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Because of the magnitude of construction of the Pennsylvania Turnpike and because its design incorporates the latest developments in highway engineering, it was decided to devote this entire issue to the project. The turnpike job compares favorably with large construction projects in total cost but exceeds them in tempo due to the required completion date. Since engineers and contractors generally, did not have a clear idea of this huge project, and since it is the first toll superhighway to be built in the United States, in which tolls are expected to maintain the highway as well as amortize the bonds, it is hoped we will be pardoned for devoting one issue, exclusively, to this new frontier in highway development.— *Editor.*

EVOLUTION OF THE PENNSYLVANIA SUPERHIGHWAY

THE first known attempt to utilize the right-of-way of the old South Penn Railroad, which was projected between the years of 1881 and 1885, as a highway, was in 1913-14 when the Pennsylvania Department of Highways ran a survey to utilize the old cuts and fills for the location of Route 49 between New Baltimore and the Allegheny tunnel, this location being in the western part of Pennsylvania. The survey was never utilized and the project lapsed into the unknown until the 1935 Legislature sponsored a WPA project under the supervision of the Department of Highways for "an engineering investigation of a proposed highway south from Harrisburg to Pittsburgh." This session of the Legislature passed the bill on the strength of public sentiment for the superhighway piercing the mountain ranges between these points. The investigation was to follow the route of the old South Penn Railroad and was called the South Penn Survey. Operations started out of the state highway department office at Holidaysburg, Penn.

The first step taken in the location survey was that of plotting the line of the old South Penn Railroad on U.S.G.S. sheets and the study of this line in the Holidaysburg office. The U.S.G.S. sheets were photographed and enlarged four times to facilitate and expedite the study to be made. Field survey corps were set to work over the entire line and temporary offices were established along the proposed route. Surveying corps were made up of selected engineers available from WPA personnel and they began staking a traverse line through the existing cuts and fills abandoned by the old South Penn Railroad.

Considerable mileage of the surveys was through inaccessible mountainous country covered by second growth scrub oak and brush. The first survey began in January, 1936, and by March, 1936, a period of two months—sufficient field work had been done that preliminary office procedure could be undertaken at all points along the line. The evolution of the engineering procedure was, by gradual stages, placing emphasis on economy and progress. This is exemplified by the fact that in the various temporary field offices only one or two draftsmen were necessary to take care of this preliminary study. It must be borne in mind, however, that the WPA survey was to be used as an investigation report on the feasibility of constructing a superhighway through the southern tier of counties of Pennsylvania. By April, 1936, controlling field offices were established at Mt. Pleasant, Somerset, Everett, and Newville (later at Shippenburg) with a slight increase in the office personnel.

As the work progressed and the force increased, a

squad system was used so that each man specialized in a particular phase of the job which greatly added to speed and efficiency in the preparation of all plans.

By May 1, 1937, the survey was complete enough that a full report could be made to the Pennsylvania Legislature. After careful deliberation in which consulting engineers and other interested individuals presented their reports the Legislature recommended the projection of the route.

On May 21, 1937, the Legislature passed Act 211, creating the Pennsylvania Turnpike Commission as an instrumentality of the commonwealth, authorizing and empowering it to construct and operate and maintain a turnpike through the Allegheny mountains and to acquire the right-of-way and construct the tunnels and bridges necessary to provide an all-weather highway with low grades between the eastern and western sections of the state. The commission was authorized by this act to issue turnpike revenue bonds of the commonwealth for the purpose of paying the costs of the project. The commission consists of five residents of the state, one of whom is the Secretary of Highways of the Pennsylvania State Highway Department, acting in the capacity of ex-officio member. The remaining four members were appointed by the governor with the approval of two-thirds of the senate. With the establishment of the Pennsylvania Turnpike Commission, central offices were located in Harrisburg, the capital city, and all administration and engineering were directed from this point to the various established field offices.

View of West Portal of Ray's Hill Tunnel During Construction in 1885. Like the Other Tunnels on the South Penn Railroad Project, It Was Not Completed. Andrew Carnegie Is Shown at Left in Foreground.

Working from the survey made of the old South Penn Railroad, a system of stationing was established running from west to east, beginning at station 0+00 at each county line. Each divisional field office was assigned sections from which all surveys and plans work was to emanate. By this time the various divisional office forces were increased to cope with the ever increasing amount of engineering involved. Due to the fast progress necessary in the preparation of plans and the establishing of preliminary survey lines, many short-cut methods were used by both the field and office forces.

The present alignment is an outgrowth of many studies on the most economical and practical location. A great number of these studies had to be made since the alignment of the old South Penn Railroad was not suitable at various points for the construction of a superhighway or because the quantities and other costs involved would have been prohibitive. Only about 34 miles of the original right-of-way of the old South Penn Railroad are included in the present alignment.

By the spring of 1938 surveys were started of the property through which the route passed and drawings were prepared for each property. This grew into a separate right-of-way unit for each divisional office which, through the direction of the central office, estimated the damages and recommended locations as affected by property. Due consideration was given to each property owner and to all intersecting state, county, and township roads and to right-of-access for property by using side roads or lanes. But this time the engineering organization was working under more definite instructions and specifications as set up by the Pennsylvania Turnpike Commission.

During the summer of 1937 a $75,000 tunnel drainage contract was let for opening and draining the abandoned South Penn Railroad tunnels.

The draining of the water from the old partially driven tunnels was completed and the field corps were able to investigate and survey these uncompleted tunnels. Due to the length of the project and the intention of drilling tunnels from both portals it was necessary to run very accurate elevations for bench marks, adjusting the runs to meet those of the other divisions and establishing U.S.G.S. elevations. Similarly, true north bearings were determined from Polaris and deflection angles in the alignment were adjusted for the curvature of the earth.

Rod soundings were made to determine the rock line in all cuts. These results were analyzed, interpreted by the geologists and used in modifying the cut slopes and determining the shrinkage factor of the various materials to be encountered. At the site of proposed structures test holes were dug and rod soundings taken or core borings obtained. These were analyzed for soil bearing conditions and used to determine the elevation and size of footings as well as the type of structure.

The design and preparation of plans for roadway, tunnels, and structures were well under way at this time and in the subsequent months they reached greater proportions and were ready for preliminary investigation and then final drafting. Through the special efforts of Mr. Walter A. Jones, Chairman of the Commission, the financing was completed.

Time Limit Spurs Tempo

Final notice of approval for financial assistance by Federal Authorities was received on Oct. 10, 1938. Arrangements were consummated immediately to complete the preparation of plans for the first contract of approximately 10 miles in length. This section was advertised four days later, on Oct. 14, and bids were received Oct. 26. Next day the contractor started operations. This was necessary to meet the starting date as established by the PWA grant agreement. It should be noted that only four days were allotted for the completion of plans, the design of structures, the preparation of contract documents, and the actual advertising of the first contract along with many other incidental items relative to the plans and the contract involved. This absolute necessity for speed as disclosed by the above statement has been and continues to be paramount throughout the various departments. A plans schedule was set up for the entire job involving all proposed work. Additional personnel was secured as rapidly as possible, emphasis being placed upon the qualifications of each individual before being selected as an employee.

At this writing all grading and drainage contracts have been awarded for the 160 miles of roadway and tunnels,

with additional mileage involved for the necessary construction of all side roads intersecting the route. In addition, contracts have been awarded on 74.83 miles of two 24-ft. lanes of reinforced concrete paving and 6.7 miles of tunnel paving. The preparation of plans for the turnpike construction itself represents only a part of the total work involved in completing the adopted schedule. At the start of the project the line crossed approximately 180 public roads. Included in the planning task was the necessity of preparing plans acceptable to the public authorities responsible for these intersecting roads and the design of structures for all public highways which must cross the turnpike. All state highway relocations and crossings were obliged to meet one of three requirements: First, any adjustment in location was made only to secure shorter distance; second, to require less maintenance cost; and third, to reduce hazards. Completion of satisfactory arrangements, in the short time available, the relocation of all state highways, and the elimination of grade crossings through the use of underpasses or overhead structures indicate the excellent cooperation accorded the commission by the state highway department.

Typical View of Partially Completed Old South Penn Fill. Some of These Were Used for the Pennsylvania Turnpike.

In organizing the personnel, the commission was fortunate in securing the services of a large group of qualified bridge designers and draftsmen. Several of them were loaned to the commission by the Pennsylvania Department of Highways and more secured from the American Bridge Co. These have completed their assignments and have returned.

To obtain some idea of the size of the bridge program, it may be noted that the contract value of bridges required is over 50 per cent more than the replacement cost of all bridges destroyed in the state of Pennsylvania in the disastrous flood of 1936.

In summing up the turnpike tempo it appears that construction is on its way to a successful and timely completion by June 29, 1940, the date set by the Federal agencies. Of special interest is the speed with which the latest contracts are progressing. Many of these contractors have sublet considerable portions of their work to others.

To provide uniformity of inspection by the field staff and to eliminate possible delays arising from misinterpretation of plans and specifications an inspectors' school was established in one of the divisional field offices. Mastery of the specifications is an arduous task for new personnel, and frequently for experienced engineers and inspectors. On a job where speed and long hours are demanded by the entire personnel every scheme for efficiency which has merit must be used. Most all classes of field men from inspectors to project engineers are required to pass several weeks of inspection training before being sent to their respective assignments in order to eliminate the human element of a variance in the interpretation of many items as set forth in the specifications. Staff members also make frequent trips over the line to assist in maintenance of uniformity of specification interpretation.

FINANCING THE TURNPIKE

By WALTER A. JONES

Chairman, Pennsylvania Turnpike Commission

BUILD a 160 mile superhighway halfway across the State of Pennsylvania and also raise the money with which to do it! That is the little task the Pennsylvania Turnpike Commission was given by the 1937 Legislature. It was known that this was no ordinary highway project; in fact it was to be the first toll superhighway in the United States. It will be the longest stretch of grade separated highway in the United States. It had to be done and in operation by June 29, 1940.

The act of the 1937 General Assembly which created the Pennsylvania Turnpike Commission authorized and empowered it to construct, operate, maintain and finance a turnpike from Middlesex to Irwin.

After the commission was organized, a private syndicate was formed to purchase bonds and provide the necessary funds for construction. Subsequently, it was decided that several millions of dollars in interest payments could be saved if the federal government, from a national defense standpoint would lend financial assistance. As finally completed the Public Works Administration agreed to ear-mark a grant of $26,100,000 and the Reconstruction Finance Corporation agreed to buy the commission's bonds in an amount not exceeding $35,000,000. These bonds, paying 3¾ per cent interest, will be retired by tolls to be collected from users of the highway. The commission expects to complete amortization of the bonds by 1954, at which time the highway will be turned over to the state for free use thereafter by the general public.

Effecting this financial arrangement was not all smooth sailing, as we quickly determined. In my capacity as chairman of the commission, I figuratively beat a path between Harrisburg and Washington before the Federal Government agreed to finance the project. There were many days when the prospects of financing looked very dark; some of my friends even urged me to give up the idea. "You're shooting too high," they said. "It can't be done." The entire scheme hinged with PWA; the

$26,100,000 grant we were asking represented the largest single PWA grant requested in that program. The RFC was willing to go along once we obtained the 45 per cent grant from PWA. With the assistance of Secretary of the Interior Harold L. Ickes, who at that time was Administrator for PWA, we obtained President Roosevelt's assurance that he would sanction a PWA grant.

But one day our hopes seemed about to be dashed. Mr. Ickes telephoned me. "I have bad news," he said, "the President will give you only $20,000,000." Mr. Ickes showed me a radiogram from San Francisco where President Roosevelt was about to put out to sea for a prolonged vacation trip. It looked as if the arrangement was going to fall through unless we could get the President to change his mind.

We immediately dispatched a wire to the President. Fortunately, it reached him a few minutes before his cruiser was scheduled to sail. Mr. Roosevelt's reply was: "I'll let you have twenty-five million." And then Mr. Ickes took the responsibility of adding the last million required to build the road. Financing of the Pennsylvania turnpike had been completed.

Not only will the commonwealth get a $61,000,000 superhighway for free use by the public within 15 years but it will also get a cash premium of more than $10,000,000 besides. By 1954, the commission estimates it will have an accumulated surplus of $2,918,000 which we hope will be turned over to the motor fund. In addition to this amount, the state will benefit by direct collection of an estimated $7,500,000 in increased gasoline taxes paid by users of the highway in the 15-year period. The commission will be dissolved upon redemption of the bonds and all funds of the commission not required for payment of the bonds, and all machinery, equipment and other property belonging to the commission shall be vested, under the act, in the department of highways.

We have estimated that most of the expected increase in gasoline taxes will be paid by "induced" traffic—that is, new travel developed by the advantages of the highway, such as safety, driving convenience and savings in time. At the same time travel on the state highways system as a whole is expected to continue its normal growth of about 5 per cent a year.

Construction of new traffic facilities has always resulted in new traffic, or substantial increase of previous traffic flow. I need only cite the case of the Delaware River toll bridge which increased traffic between Philadelphia and Camden by 75 per cent, an increase which the former ferry boats never could have developed, let alone have handled. In the case of five other bridges throughout the country, the increase in traffic has ranged from 54 per cent to as high as 422 per cent.

A very important factor which is not generally known is the fact that the turnpike must be maintained out of the toll receipts. This means that the taxes on gasoline used by automobiles, trucks and busses traveling on the turnpike will go entirely to the motor fund of the state, although the latter will not be called upon to bear any cost of operating the highway. We estimate that the gas taxes paid by turnpike users will amount to approximately $500,000 a year which by the end of 1954 will total about $7,500,000.

Pennsylvania Turnpike Commission.
Left to Right: Mr. Charles T. Carpenter; Mr. Thomas J. Evans; Mr. Walter A. Jones, Chairman; Mr. Frank Bebout; Mr. I. Lamont Hughes, Ex-officio Member, Secretary of Highways, Pennsylvania.

To save interest payments, the commission is drawing proceeds of the bond sale as funds are required instead of taking the entire $35,000,000 at one time. The first draft that the commission made on the bond proceeds amounted to $10,000,000. After that initial allotment was made, the PWA gave us $6,000,000, representing the first proportional installment on its grant of $26,100,000. Payments on the remainder of the PWA grant will be made from time to time as work progresses on the highway and the commission certifies that it has earned the additional installments to be requested.

Sole security for the bonds will be the tolls. The turnpike act specifically provides that the bonds shall not be deemed to be a debt of the commonwealth or a pledge of the faith and credit of the commonwealth. That these bonds are considered good investments by banking houses is indicated by the fact that the initial block of $10,000,000 resold by RFC on the open market was over-subscribed by approximately $6,000,000. Traffic engineers and consultants employed by the commission have prepared an amortization table by which the commission plans to complete retirement of the bonds by 1954. They estimate that the gross earnings from tolls will be $2,670,000, in the first year of operation, increasing to $4,260,000 in the fifth year and to $4,832,-

000 in the tenth year. The average toll for one-way through trip will be approximately $1.25 for passenger cars, about $3 for medium trucks, and from $4 to $10 for larger motor trucks.

Under the direction of the commission, the traffic engineers of Parsons, Klapp, Brickerhoff & Douglas, of New York City, made a comprehensive study of the volume of traffic in Pennsylvania and also traffic trends, not only in the commonwealth, but in New England and the Middle West—this for the purpose of determining the flow of traffic and the movement of vehicles for long distances across the country. The J. E. Greiner Co., Consulting Engineers, Baltimore, Md., concurred in the estimate of the traffic engineers with respect to the volume of traffic which might be diverted from present routes and also that which might be induced through the creation of this new facility. We believe that these estimates are conservative.

The following is quoted from the report of the traffic engineers:

"In order to arrive at the desired estimates of traffic, tolls, and resulting gross earnings from the proposed Pennsylvania Turnpike, the investigation required a considerable variety of determinations—not only basic facts as to the existing traffic, but as to the trends of growth, the attractiveness of this highway to vehicles now following other routes, and the effect upon them of the offered time saving, actual economy in operating costs, safety, and other factors.

"The demand for predetermining the traffic to be anticipated from a given improvement in highways, the construction of bridges, vehicular tunnels and other facilities requiring large expenditures, has necessitated the development of basic principles and methods of analysis which have been developed by traffic engineers, particularly during the past fifteen years.

"There are ascertainable facts from public records such as sales of gasoline per annum for a district, registration of vehicles, population growth, and records of tolls on many bridges. The practice in more recent years of the highway departments of many states has been to make periodic traffic counts at important points on the main highways and the record of these is generally available. The U. S. Bureau of Public Roads has gone into this matter at great expense and developed methods, statistical facts and a great deal of valuable data of general application.

"In an individual case such as the Pennsylvania Turnpike, experience and intelligent application and use of available statistics, together with actual counts of traffic for such periods as are financially and practically possible, form a basis for the weighing of the traffic probabilities that can be discussed and analyzed with assurance that with continuation of existing conditions a close approximation to the results can finally be obtained.

"The Pennsylvania Turnpike not only requires all of the usual investigations to be made on a bridge or tunnel of short length, but also the wider field of inquiry as to the flow of traffic and movement of vehicles for long distances across the country. This involves not only passenger cars but trucks and busses, and the many conditions affecting the development and growth of this long distance vehicle travel.

"We submit this report as embodying our analysis and estimate of the probable initial gross revenue from tolls to be obtained from the operation of the projected Pennsylvania Turnpike based on the assumption of a period of normal average business conditions."

Following is a summary of the major factors entering into the traffic estimates, as detailed in the report of the traffic engineers:

Total annual vehicular traffic over U. S. Routes 30, 22, 40, 6 and 20, in 1937	3,500,000
This figure represents results of a scientific count made by the traffic engineers, and was confirmed by the findings of the Department of Highways in their traffic studies.	
Vehicles rejected and therefore not prospects for the Turnpike	2,030,000
During the traffic survey the engineers utilized and supervised 200 employees of the State Department of Highways in making the traffic count. They worked in three 8-hour shifts and manned ten observation stations on Routes 22, 30, and 40. The data gathered was systematically recorded by them on some 90,000 cards, which were then classified by the traffic engineers in groups as to types of vehicles and analyzed as to origin and destination of trip. The completion of this analysis required two months of intensive work and resulted in a rejection of 58 per cent of the grand total of vehicles observed. Thus only 42 per cent of all vehicles observed were included by the engineers as prospective users of the turnpike.	
	1,470,000
This figure representing normal prospects for the turnpike is increased by 20 per cent to represent the normal growth of traffic between 1937 and 1941 (which is estimated as the first year of the turnpike's operation)	294,000
	1,764,000
This figure is increased by 10 per cent for increase in traffic during the first year as a result of this modern and convenient facility	176,400
	1,940,000
This figure is reduced by 30 per cent to allow for prospective users of the turnpike who may be unwilling to pay tolls	582,120
	1,358,280
Estimated traffic first year of operation (approximately)	1,300,000
Add 20 per cent for induced traffic during 1942	1,560,000
Add 15 per cent for induced traffic during 1943	1,794,000
Add 10 per cent for induced traffic during 1944	1,973,000
Add 5 per cent for induced traffic during 1945	2,070,000

Based upon the above estimates of volume of traffic and also upon the schedule of tolls recommended by the traffic engineers, the following is an estimate of the gross earnings during the first ten years of operation:

Type of Vehicle	Estimated Receipts First Year
Pennsylvania passenger cars	$ 725,000
Foreign passenger cars	525,000
Heavy trucks	1,080,000
Medium trucks	270,000
Light trucks	30,000
Busses	40,000
Estimated receipts from first twelve months of operation	$2,670,000
Increase during second year (about 20 per cent)	534,000
Estimated receipts from second year	$3,204,000
Increase during third year (about 15 per cent)	480,000
Estimated receipts from third year	$3,684,000
Increase during fourth year (about 10 per cent)	368,000
Estimated receipts from fourth year	$4,052,000
Increase during fifth year (about 5 per cent)	208,000
Estimated receipts from fifth year	$4,260,000
Increase during sixth year (about 4 per cent)	180,000
Estimated receipts from sixth year	$4,440,000
Increase during seventh year (about 3 per cent)	140,000
Estimated receipts from seventh year	$4,580,000
Increase during eighth year (about 2.2 per cent)	100,000
Estimated receipts from eighth year	$4,680,000
Increase during ninth year (about 2 per cent)	90,000

Estimated receipts from ninth year.....$4,770,000
Increase during tenth year (about 1.3 per cent).... 62,000

Estimated receipts from tenth year.....$4,832,000

During the first 10 years, the estimated average of receipts from tolls is $4,117,200 per year. After deducting $566,000 representing the average operating and maintenance expense, together with reserve for extraordinary repairs, the average annual net revenues of $3,551,200 are equal to nearly three times the annual interest requirements on $35,000,000 bonds during the first 10-yr. period. Continual application of surplus to retirement of bonds will retire the entire issue by 1954.

The bonds will be redeemable on and after August 1, 1947, at principal and accrued interest. However, it is planned to retire $7,000,000 of the bonds by purchase prior to the call date—$2,000,000 worth of the issue each in 1944 and in 1945 and $3,000,000 in 1946. Subsequent issues to be retired follow: 1947, $3,000,000; 1948, $3,000,000; 1949, $3,000,000; 1950, $4,000,000; 1951, $4,000,000; 1952, $4,000,000; 1953, $4,000,000; 1954, $3,000,000. Premium payments will increase the $35,000,000 retirement to $36,310,000. Table I shows application of all net revenues to bond retirement.

TABLE I—FINANCIAL RETIREMENT SCHEDULE

Year	Number of Vehicles Estimated	Gross Revenues Estimated	Operation and Maintenance Including Reserve	Net Income	Interest	Accumulated Balance	Total Retirement Including Premium	Accumulated Surplus
1941	1,300,000	$2,670,000	$ 408,000	$2,262,000	$1,312,500	$	$	$ .....
1942	1,560,000	3,204,000	428,000	2,776,000	1,312,500	.....	.....	.....
1943	1,794,000	3,684,000	448,000	3,236,000	1,312,500	1,461,500	.....	1,461,500
1944	1,973,000	4,052,000	458,000	3,594,000	1,312,500	3,743,000	2,080,000	1,663,000
1945	2,072,000	4,260,000	653,000	3,607,000	1,237,500	4,182,000	2,080,000	2,102,500
1946	2,160,000	4,440,000	653,000	3,787,000	1,162,500	4,877,000	3,120,000	1,757,000
1947	2,220,000	4,580,000	653,000	3,927,000	1,050,000	4,859,000	3,120,000	1,739,000
1948	2,270,000	4,680,000	653,000	4,027,000	937,500	5,053,500	3,120,000	1,933,500
1949	2,325,000	4,770,000	653,000	4,117,000	825,000	5,450,500	3,120,000	2,330,500
1950	2,350,000	4,832,000	653,000	4,179,000	712,500	6,022,000	4,160,000	1,862,000
1951	2,350,000	4,832,000	653,000	4,179,000	562,500	5,778,500	4,160,000	1,618,500
1952	2,350,000	4,832,000	653,000	4,179,000	412,500	5,685,000	4,140,000	1,545,000
1953	2,350,000	4,832,000	653,000	4,179,000	262,500	5,761,500	4,120,000	1,641,500
1954	2,350,000	4,832,000	653,000	4,179,000	112,500	6,008,000	3,090,000	2,918,000
		$60,500,000	$8,272,000	$52,228,000	$12,525,000		$36,310,000	$2,918,000

Administrative

Offices of the commission are located at 11 North Fourth St., Harrisburg, Pennsylvania. Following is a list of the commission members, department heads and affiliated agencies:

Commission: Walter A. Jones, Chairman; Frank Bebout; Charles T. Carpenter; Thomas J. Evans; I. Lamont Hughes, Secretary of Highways, (Ex-Officio Member); John D. Faller, Secretary-Treasurer.

Administrative: William T. Staats, Assistant to the Chairman; Paul B. Noftsker, Administrative Assistant; Wm. J. Buchy, Purchasing Agent; Walter C. Young, Personnel Director; Frank Green, Comptroller; George J. Vukmanic, Publicity Director.

Legal Division: John D. Faller, Chief Counsel; James Boyer, Chief of Bureau; Gerard B. Gilbert, R/W Coordinator; E. Elliott Middleton, Chief R/W Property Contacts.

Engineering: Samuel W. Marshall, Chief Engineer; Roger B. Stone, Chief Construction Engineer; Fred S. Poorman, Asst. Chief Engineer; Charles M. Noble, Special Highway Engineer; E. J. Kinney, Plans, Specifications and Contract Engineer; Richard Graef, Chief of Bridges; John D. Paul, Assistant to Chief Construction Engineer; George H. Elsenhans, Assistant to Chief Construction Engineer; Gerald Tyler, Registered Architect; Howard M. Van Gelder, Chief Electrical Engineer; Ivan L. Tyler, Materials and Inspection Engineer; Dr. A. B. Cleaves, Chief Geologist; Joseph Gorman, Assistant Geologist; Edgar O. Marty, Chief Mechanical Engineer.

Tunnels: Richard M. Merriman, Chief Engineer of Tunnels, Headquarters at Everett; W. C. Kline, Tunnel Construction Engineer; Milton Brumer, Engineer of Tunnel Design; Earnest R. Dinkle, Tunnel Resident Engineer, Laurel Hill; Cass A. Budnik, Tunnel Resident Engineer, Sideling Hill and Rays Hill; Eugene Nedbor, Acting Tunnel Resident Engineer, Blue and Kittatinny Mountains; P. C. Cox, Acting Resident Engineer; Allegheny Tunnel; F. C. Sellnow, Resident Engineer; Kittatinny, Blue and Tuscarora Mountains; William Atkins, Tunnel Unit Office and Plans Engineer; J. M. Kantner, Tunnel Unit Construction Plans Engineer at Somerset; and K. C. Bellows, Tunnel Resident Engineer, Tuscarora.

Safety: Tom W. Osgood, Chief Safety Engineer, Everett; Assistant Safety Engineer Harold W. Morgan, Somerset; Assistant Safety Engineer C. Harold Fast, Mt. Pleasant; and Assistant Safety Engineer Thomas B. Reilly, Shippensburg.

Field Offices—Mt. Pleasant: Fred D. Franz, Plans Engineer; Charles Hershberger, R/W Chief; George Chapman, Construction Engineer. *Somerset:* D. D. Williams, Plans Engineer; J. C. Gwynne, R/W Chief; Bowie G. Etchison, Construction Engineer; F. E. Taylor, Assistant Construction Engineer. *Everett:* Jack Wolfe, Plans Engineer; Hayes Cunard, R/W Chief; Samuel G. Nowell, Acting Construction Engineer; Lee G. Lehman and Harry I. Davis, Assistant Construction Engineers; Joseph Sime, Chief of Surveys. *Shippensburg:* C. L. Clark, Plans Engineer; R. M. Huber, R/W Chief; H. L. Lundy, Construction Engineer; J. P. McInnis, Assistant Construction Engineer; A. H. Brill, Chief of Surveys.

Public Works Administration: James F. Murphy, Project Engineer; Harold C. Lightfoot, Assistant Project Engineer; T. R. Rampy, Resident Project Auditor; S. H. Bollenbacher, Chief Resident Engineer Inspector, Mt. Pleasant Office, P.W.A.; Charles Elcock, Chief Resident Engineer Inspector, Somerset Office, P.W.A.; C. O. Diffenderfer, Chief Resident Engineer Inspector, Everett Office, P.W.A.; Joseph Cichiny, Chief Resident Engineer Inspector, Shippensburg Office, P.W.A.

Reconstruction Finance Corporation: Col. F. E. Lamphere, Inspecting Engineer; H. F. Bucher, Assistant Inspecting Engineer; J. S. Long, Assistant Supervising Engineer; W. A. Moyer, Resident Project Auditor.

State Highway Department: Thos. C. Frame, Chief

Engineer; Robert J. Harper and Henry E. Kloss, Engineers.

Consultants: J. E. Greiner Co., Consultant for the Commission and Bondholders; Charles M. Upham, Engineer Director of A.R.B.A., Highway Consultant to the Commission; Ralph Smillie of the Port of New York Authority, Consultant on Tunnels, and A. J. Sweet, New York, Consultant on Lighting.

Right-of-Way

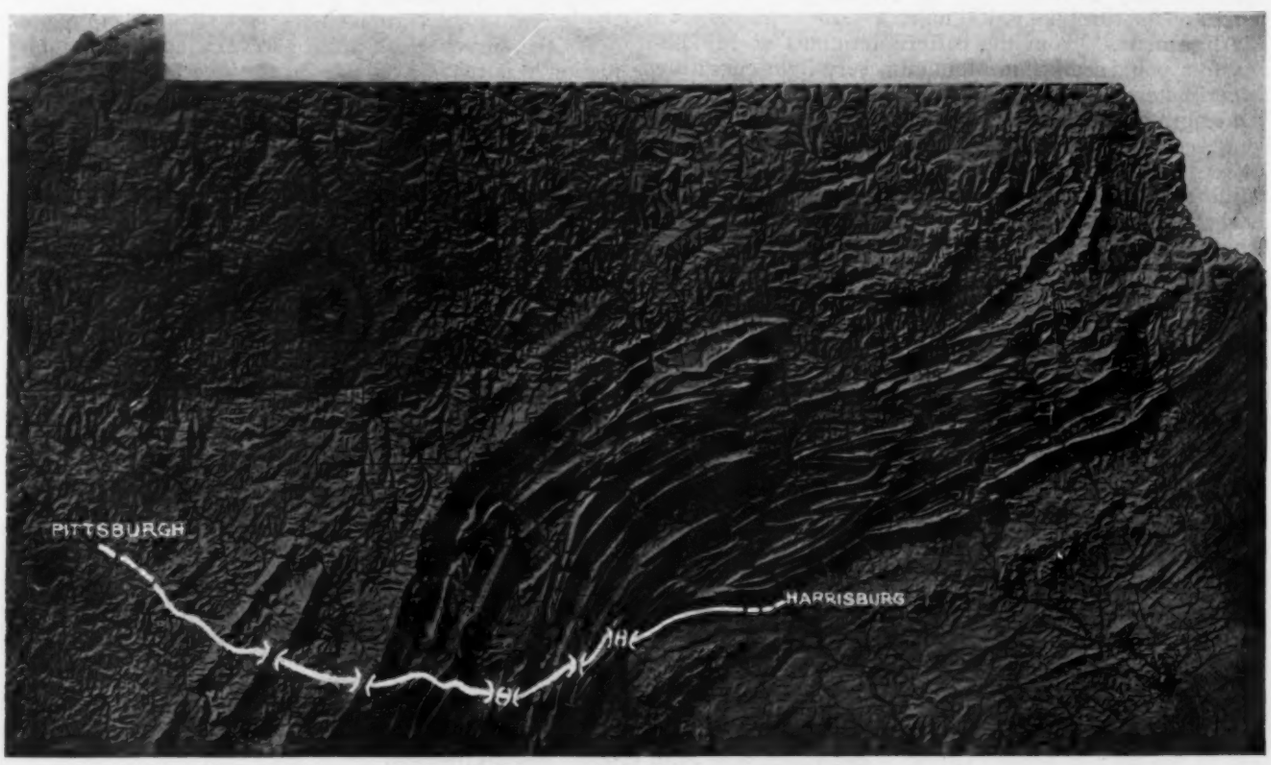
All right-of-way problems are handled in the central office right-of-way unit which serves in the capacity of a medium between the four field right-of-way departments and the legal bureau. The unit's duty is to carefully check all property plans made in the four field offices and to utilize these plans in the preparation of descriptions for bonds and court petitions on the right-of-way necessary. They also prepare such additional plans as are required for the relocation or change of state highways, legislative routes, township roads, private roads, and other (including utility) rights-of-way.

A brief outline of some of the requirements of this work can be explained in discussing an individual property. After the field corps runs the necessary survey, tying the property corners to the turnpike center line, the field office must then compute the acreage of the required right-of-way, prepare the property plan, make copies of the property owner's deed, filed in the local courthouse, and forward all of this work to headquarters.

The property plan in itself is prepared in order to show a detailed drawing for that portion of the property actually required and to show a location map picturing the entire farm with the turnpike right-of-way strip spotted in relation to the whole. The entire property, as shown on the location map, including buildings and improvements must agree with the property owner's recorded deed description, and too, the map should show at a glance the property owner's home and his access to a public road. A computed traverse, utilizing all courses and distances as shown on the detailed drawing, must be made and found to close. All topography which falls within the required right-of-way must be shown as the destruction of buildings, fruit trees, fence lines, private lanes and so on may be considered elements of damage.

Throughout many miles of the proposed alignment, the old South Penn right-of-way is bringing to light many interesting details, not only in relation to location and alignment but also in regard to the aspects of the numerous types of their land titles gained at the time of construction. The commission decided on a general 200 ft. right-of-way with reservations for extra widths at tunnels, interchanges, deep cuts, and fills. In the case of tunnels, the full 200 ft. is taken over the tops of the mountains with extra widths at and adjacent to the tunnel portal approaches. In searching for the legal recordings of the openings for all township and state roads, it is surprising to find how many supposedly public roads have not been legally opened and how many so-called private roads were legally publicly opened years ago. The headquarters unit, with information from the right-of-way field offices, has been able, through the legal bureau, to inform property owners of conditions existing of which they have never been aware. Some owners have been told of property they own and which they did not realize and others of property they have claimed and used but which they do not own. In several cases, there has been found an over-lapping of property according to the plotted deed descriptions and, in some matters, an hiatus has been discovered between supposedly adjacent properties.

Needless to say, in the consideration of approximately



Crossing the Appalachian Mountains, a Natural Barrier, The Pennsylvania Turnpike Passes Through Seven Tunnels. From Left to Right These Tunnels Are: Laurel Hill, Allegheny Mountain; Ray's Hill, Sideling Hill, Tuscarora Mountain, Kittatinny Mountain, and Blue Mountain.

730 properties being crossed by the turnpike right-of-way, together with others affected by the relocation of state or township roads, channel changes, and utility relocations, the unit has been working at full capacity and under a strict output schedule for the past fourteen months. However, the work of this unit far from completes the journey to a "Contractor's Right of Entry." All plans and descriptions for bonds and petitions, after being prepared, must be transmitted to the legal bureau.

From this point, right of entry ceases to be a technical problem and becomes a problem of personalities, contacts, negotiations and court procedure. Each step first involves the approval of five various agencies and, after this, there must be found in each and every case a common meeting ground whereby what once belonged to an individual becomes the property of the Pennsylvania Turnpike Commission. It is of vast importance for the reader to note that all properties have the "contractor's right of entry" where in some instances the center line of the turnpike was not definitely established prior to June 15, 1939. But in order to circumvent the technicality of the law, a bond was posted with the local court whose jurisdiction covered the property involved and thus gave the contractor his "right of entry."

The bond as set by the court was an assurance that the property owner would be paid an equitable amount for damage incurred.

DESIGNING THE ROADWAY

Safety at High Speed Prime Consideration in Design of All Elements

THE route of the turnpike leaves Pennsylvania Route 11, at Middlesex (refer to map insert) and extends in a southwesterly direction, crossing the Lincoln Highway near Breezewood, and continues in a westerly direction parallel to and somewhat south of the Lincoln Highway. This location will serve a considerable area not previously reached by through highways, and which heretofore lacked direct and economical transportation facilities to industrial centers in the east and west. The western terminus is located near Irwin approximately 20 miles east of Pittsburgh. The total length of the turnpike is 160 miles.

Alignment.—From the eastern terminus at Middlesex to a point near Blue Mountain, very light curvature is encountered and at several other locations throughout the length of the turnpike where topography will permit, long sections of excellent alignment are obtained. In more difficult terrain sharper curves may be anticipated, with the most difficult alignment and sharpest curves being located in a section approximately six miles in length immediately east of Allegheny tunnel.

In the study of the alignment, turnpike engineers gave careful consideration to each individual section, and the alignment is so arranged that no abrupt change in character is encountered; that is, easy transitions are provided where a change in the character of the topography traversed requires sharper curves, and maximum grades are more numerous.

In location, advantage was taken of available locations utilizing southern and western slopes of the hills, where practicable, to obtain maximum benefit of sunshine to facilitate traveling in adverse weather conditions such as snow, ice, rain, and fog. Such locations will also reduce materially, maintenance cost for snow removal and cindering for ice conditions.

Roadway.—Study as to the width and type of roadway to be constructed included for consideration two 20 ft. travel lanes with a 4 ft. division strip and 8 ft. shoulders representing a total roadway width of 60 ft., this design being considered in view of the very difficult topography encountered at many locations throughout the length of the turnpike.

As the survey work progressed and additional information was made available on the exact conditions encountered, it was determined that a roadway consisting of two 24 ft. traffic lanes separated by a 10 ft. parkway with 10 ft. shoulders was feasible and warranted in view of the importance of the undertaking and other design features.

The adoption of two 24 ft. traffic lanes is in keeping with the modern trend of highway construction for express highways carrying both heavy truck traffic, and a large volume of fast pleasure traffic. This width will adequately provide for the movement of heavy vehicles with sufficient width for passing by faster traffic, and will tend to decrease or eliminate the cause of accidents due to carelessness or false reactions upon the part of the drivers of vehicles.

The trend for greater width of traffic lanes is unmistakable. As late as 1929, many reinforced concrete

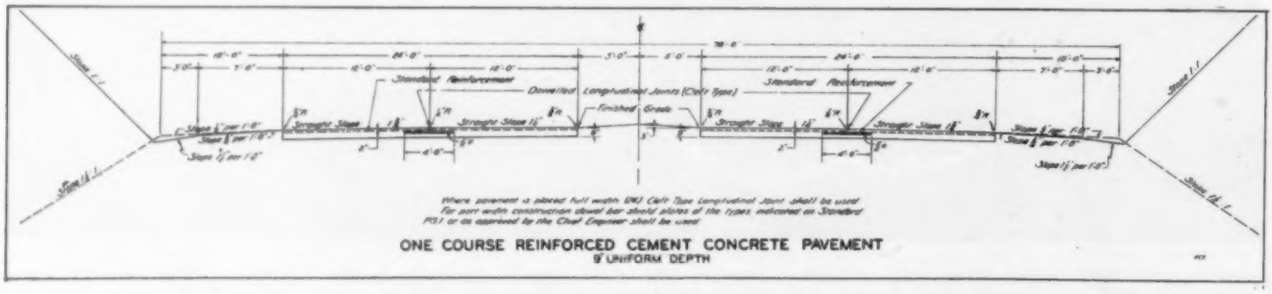

Standard Reinforcement
Doweled Longitudinal Joints (Ckt'r Type)
Finished Grade
Straight Slope
Where pavement is placed full width (Ckt Type Longitudinal Joint shall be used
For part width construction dowel bar shield plates of the types indicated on Standard
PS1 or as approved by the Chief Engineer shall be used
ONE COURSE REINFORCED CEMENT CONCRETE PAVEMENT
9" UNIFORM DEPTH

Fig. 1—Cross-section of Turnpike. Note That the Slab Is Uniform 9 in. Thickness.

pavements were constructed with a width of 16 ft., this being only sufficient to accommodate two vehicles of a maximum width permissible under the Pennsylvania motor vehicle code. The inadequacy of this width was early recognized, and more important roads were constructed 18 ft. in width, and within a few years widths of 20 ft. and more were considered the minimum for new construction on important highways. The width adopted for the construction of the turnpike, see Figure 1, is considered by many to be most satisfactory, inasmuch as it provides maximum width for freedom of movement without establishing a width sufficient to invite or encourage its use for three traffic lanes. The adoption of this width and the use of a medial strip should result in a minimum of accidents.

The use of the 10 ft. medial strip or parkway separating the two 24 ft. traffic lanes was adopted as the minimum width which would secure proper separation of traffic, and the probable maximum width, which could be obtained within economical limits in view of the rugged and mountainous terrain. The adoption of a greater width would materially affect the cost of grading, also structures spanning streams, and structures required in the separation of grades of the many intersecting public roads. The width of the parkway and shoulders designed will provide operating safety as well as parking area for emergencies and are essential for good drainage and snow removal. Grading and drainage cross-sections are shown in Fig. 2. In view of the heavy quantities and the length of the contracts the commission established the practice of awarding paving contracts after the completion of grading and drainage. The grading and drainage contracts include all excavation, the construction of all bridges both for streams and grade separations and additional surface drainage required. This practice resulted in securing contractors properly equipped and qualified to meet the very fast and exacting schedule necessary to insure completion within the allotted time. It also has the advantage of enabling maximum fill settlement prior to placing concrete pavement. Paving plans in general provide for the preparation of subgrade, the installation of subsurface drainage, the construction of reinforced concrete pavement, shoulders, and miscellaneous work.

It is recognized that some of the deeper fills will settle and therefore in certain cases, a flexible type of pavement may be provided. Past experience has indicated the difficulty in eliminating fill settlement at grade immediately adjacent to structures. All bridge approach slabs have additional reinforcing placed 2 in. from the bottom of the 9 in. uniform pavement slab. Apertures consisting of 2½ in. pipe extending through the pavement surface of the approach slabs at suitable intervals permit pumping material through the slab to fill any voids occasioned by fill settlement.

No grades in excess of 3 per cent will be encountered on the turnpike, and maximum horizontal curvature is limited to 6 degrees. Curvature of less than 6 degrees has been obtained in all but a section approximately 6 miles in length. Long vertical curves have been provided to obtain ease of riding, pleasing appearance, and most important, adequate rear and collision sight distance. Rear end collision sight distance is discussed under the heading "Headlight Sight Distance." The surface of the pavement is in full view and an object of more than 4 in. height is readily visible under all conditions

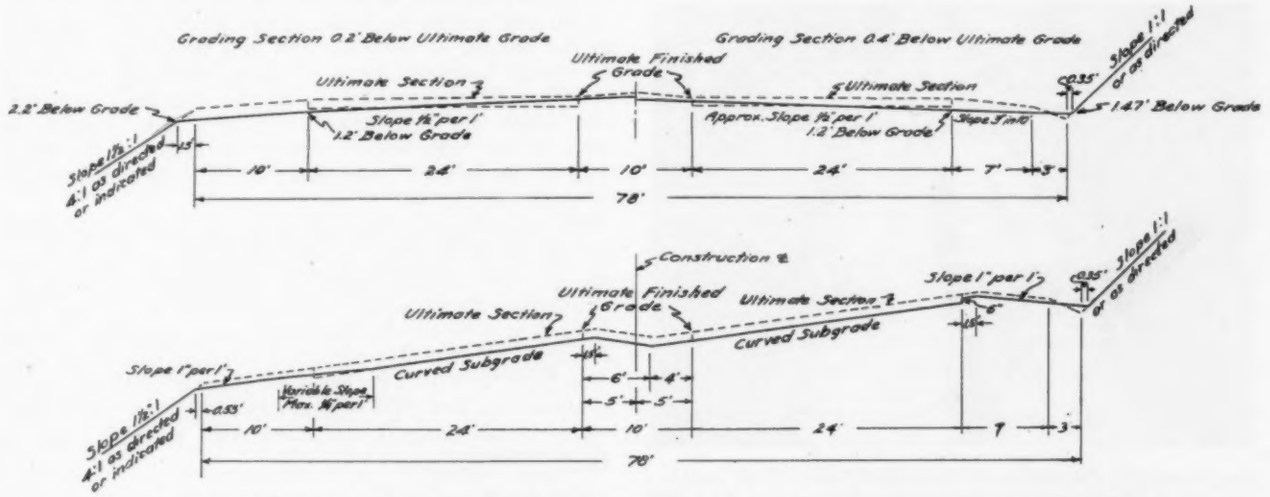


Fig. 2—Typical Sections for Grading and Drainage. Top—On Tangents. Bottom—On Super-elevated Curves.

(other than fog or inadequate lights) a sufficient distance ahead of the vehicle to enable the driver to bring the car to a stop within the available distance.

Access to the turnpike which avoids all centers of population, is available at either terminus, and at 8 other selected intermediate points. Accelerating and decelerating lanes beyond the limits of the normal travel lanes are provided to permit traffic to enter or leave the turnpike with a minimum of interference or danger to other traffic. Structures are provided to eliminate all cross traffic, as shown by the artist's conception in Fig. 6.

Tunnels are designed for two 11 ft. 6 in. traffic lanes. This width was established inasmuch as it permits maximum use of work previously performed on these tunnels, and also provides a reasonable width for proper movement of traffic in view of the restricted speeds which are essential through tunnels. The alignment and width of the approaches to the tunnels have been designed to slow traffic down with safety to reasonable speeds at each tunnel portal.

Cut slopes vary with the material encountered; however, in general a slope of 1:1 is maintained with flattening or rounding at the intersection with the natural ground, to avoid erosion, and create a more desirable appearance. Fill slopes in general are constructed to a 1½ to 1 slope. Light fills and cuts are flattened beyond these limits, to provide proper transition from cut to fill. On light fills 4:1 slopes are provided to avoid the necessity of guard fence.

Drainage.—Drainage structures have been designed

for 100 per cent efficiency for the maximum expected discharge. In general in computing this efficiency, only the water-way area of the structure below normal high water has been used. For obtaining the discharge the table of the Pennsylvania Water Resources Board was employed.

Cross drains for surface water have been provided, as required, to avoid surface water within the limits of the roadway for distances in excess of 350 ft. to 400 ft. Subsurface drainage, the need for which is evident at the time of grading and drainage, is placed as a part of the grading and drainage contract. Studies are continued, after the completion of the grading and drainage, of subsurface drainage requirements, and additional drainage determined necessary from these studies is incorporated in the paving contract. Subgrade drains and tile laterals are provided at intervals of approximately 300 ft. for subgrade stability.

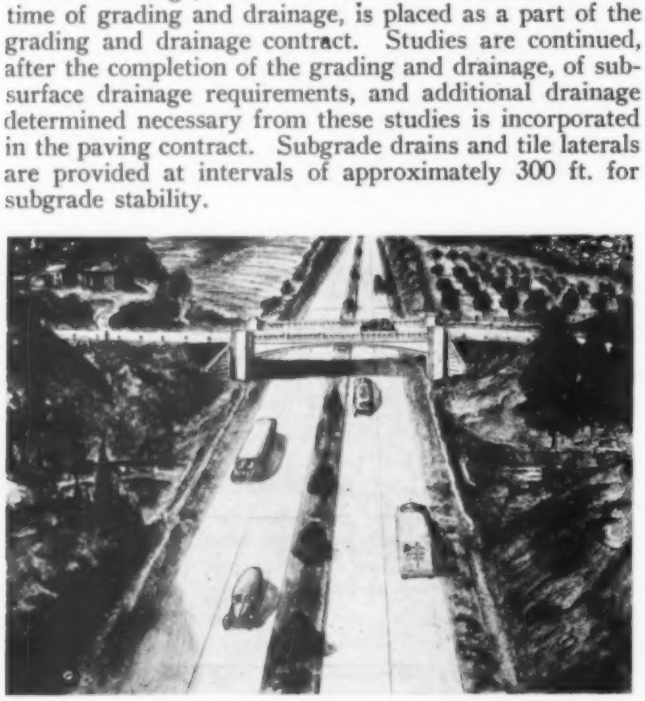


Fig. 3—Artist's Conception of Completed Turnpike. It Shows a Number of Elements of Project as Grade Separation, Dual Lanes, Private Road, Culvert, Avoidance of Towns, Guard Rail, and Cut and Fill.

Because of the very flat grades used, long cuts are encountered requiring an unusual amount of subgrade drainage, and in many instances special treatment of surface drainage. On superelevated curves, drainage of the division area is essential and inlets are provided at intervals of approximately 300 ft.

In general, cross drains consist of extra strength reinforced concrete or cast iron pipe. In deep fills the heaviest available gauge of corrugated metal pipe is provided, and as an additional precaution, full bituminous coating is specified. Specifications require solid bedding in the installation of cross drains in the heavier fills and thoroughly compacted backfill immediately adjacent to the pipe. A carefully controlled loose fill is placed immediately over the pipe. All corrugated iron pipe placed on the turnpike right-of-way is 6 in. larger than required. This was done to allow insertion of another pipe in case the original failed from erosion or acid waters.

At several locations, areas are traversed under which coal has been removed. In these instances core drill borings were taken to establish the location and approximate percentage of coal to be removed. Where the depth or character of cover is such that proper support of the roadway is not provided either against subsidence due to the removal of the coal by mining, or by fire, the entire area within the limits of the roadway is excavated to the bottom of the coal vein and properly backfilled. In special instances, stone or granulated slag backfill is provided for areas from which coal has been removed, and which are otherwise satisfactory after excavating these areas. The mined openings adjacent to the roadway are packed with rock and suitable drainage provided as shown in Fig. 4.

Surface drainage through mine areas require special consideration in view of the corrosive action of mine water. The sulphuric acid and related salts or sulphates impregnate these waters, and over a period of time will destroy or seriously damage concrete or cast iron. Triple strength vitrified clay pipe and vitrified clay lined concrete pipe have been provided for these conditions. Faces of abutments and piers of drainage structures where mine water is encountered, are lined with vitrified brick or stone masonry.

Curvature and Sequence of Horizontal Curves

Horizontal curves of thirty minutes (0° 30′) or more are superelevated. Horizontal curves of two degrees and fifteen minutes (2° 15′) or more are spiralled. Curves in the same direction are kept at least 800 ft. to 1,000 ft. apart as far as possible depending upon topography. Reversed curves are spaced sufficiently apart to assure the use of standard spirals and sufficient distance for superelevation runout. The introduction of spirals with

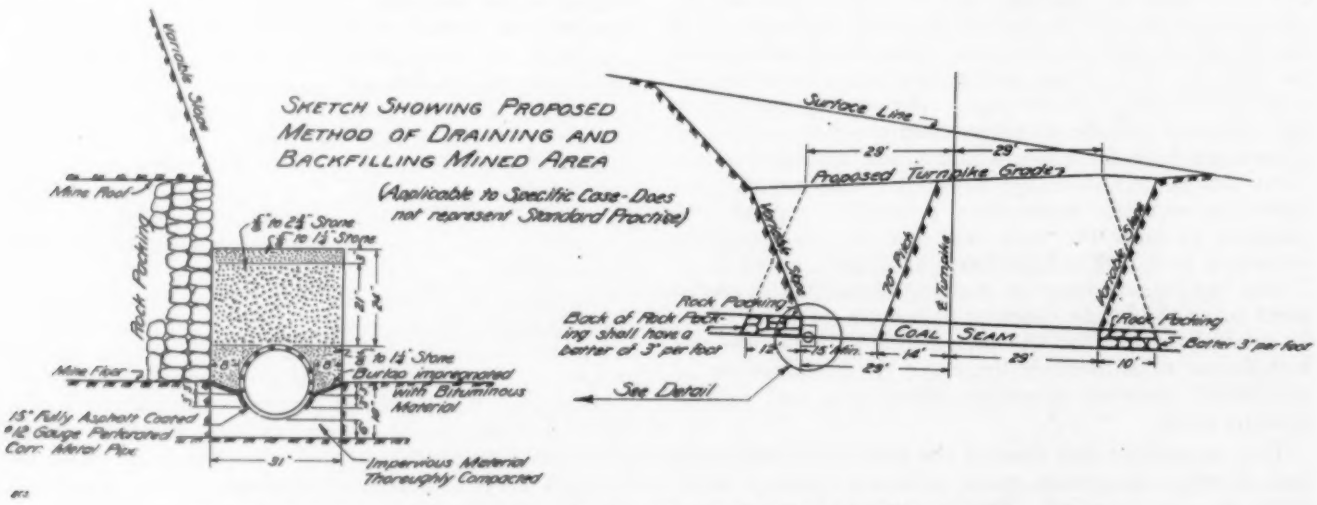


Fig. 4—Coal Seams Discovered Are Excavated and the Holes Backfilled as Shown Above.

proper design of superelevation provides a smooth easily driven transition from tangent alignment to the curve. This practice is in use on all railroad construction. It has, however, only recently been adopted for state highway work, and has been used by comparatively few states to date.

The rugged and mountainous nature of the terrain traversed by the turnpike route prevented the establishment of a uniform design speed throughout as far as superelevation and curvature were concerned. Consequently, the presence of curvature will require an adjustment of speed to conform to the speed characteristics of each degree of curve. In order to assist the judgment of the driver as to the safe speed, the superelevation has been arranged so that there is a straight line relation between the speed on the flatter curves and that possible on the sharpest curves. In addition, it is considered fundamental, that the speed over a considerable length of roadway should not fluctuate too widely. It follows that the degree of adjacent curves should bear a fairly definite relation to each other. Accordingly, the horizontal curves along the turnpike have been arranged as far as possible, so that the speeds on adjacent curves will differ only 5 to 8 miles per hour unless it was physically impracticable to use the desired degree of curve. When satisfactory sequence in curves is not practicable, particular study will be devoted to the placement of adequate warning signs. It is believed that this treatment of curvature will add materially to the safety of the superhighway by reducing to a minimum the number of places where substantial changes of driving speed will be necessary.

Superelevation.—A series of speed diagrams were prepared, as shown in Fig. 5, on which are plotted the relationship between the radii of curves and speed for various friction values, and ratios of superelevation.

The straight line relation, it is felt, will aid the judgment of the driver in determining the proper speed to drive any curve, by comparing the sharpness of the curve he is approaching as compared with the one he has just passed over. The uniformity in the relationship between superelevation and the radius of the curvature, it is believed, will prove to be a safety feature, in that a consistency in driving conditions is presented to the motorist.

In the sequence of curves, orderly groups of successive curves are incorporated in the design. Thus, if it is necessary to utilize the sharper curve because of physical conditions, the curves on either side will be so arranged that in the beginning of each series, flat curves will be used for each succeeding curve progressing up to the sharper curve, of the group, then progressively flattening the curvature again. Thus, the driver will not encounter unexpected situations which will require a radical reduction in speed. Speed reductions will take place gradually over a series of curves. Where single curves occur between long tangents, the curvature is flat so that no hazard is presented to the motorist who may be operating at a fairly high average speed on the tangents. In using the various speed-designs for superelevation, each particular curve or series of curves were studied and adjustments made. Such a course is considered desirable because the speed design cannot be uniform due to interfering topographic conditions at any given point. This is especially true of isolated curves where it is not possible to flatten them to the desired radius or where it is not possible to build up the curves in an acceptable manner.

It is to be further noted that a particular effort was made to reduce all isolated curves occurring at the ends of tangents 6,000 ft. or more in length to the very lowest possible degree, and in particular, those curves occurring at the ends of tangents up to 3 mi. in length are being reduced to 2 deg. and less, while tangents more than 3 mi. in length are generally connected with curves of 15 min. and 30 min., the longest tangent on the turnpike being approximately 13 miles.

Superelevation and spirals were designed as indicated by Figure 6 and Table I.

Headlight Sight Distance.—Design speeds are based on conservative factors for friction and rear end collision sight distance. Rear end collision sight distance is defined as the distance required for a vehicle operator to perceive and recognize conditions requiring stopping, a conservative brake reaction time, and the period or distance necessary to bring the vehicle to a stop from the designated speed using a conservative brake friction factor This distance is measured from a point 4.5 ft. above the pavement (the average height of the eye above the pavement surface), to point 4 in. above the pavement surface; that is, there is sufficient pavement surface in view of the operator at all times, to insure that the surface is entirely free of objects having a height in excess of 4 in. If sight distance is considered with respect to other vehicles, the distance is approximately twice that indicated on this standard for vertical curves, and substantially greater than that shown for horizontal curves, where cut

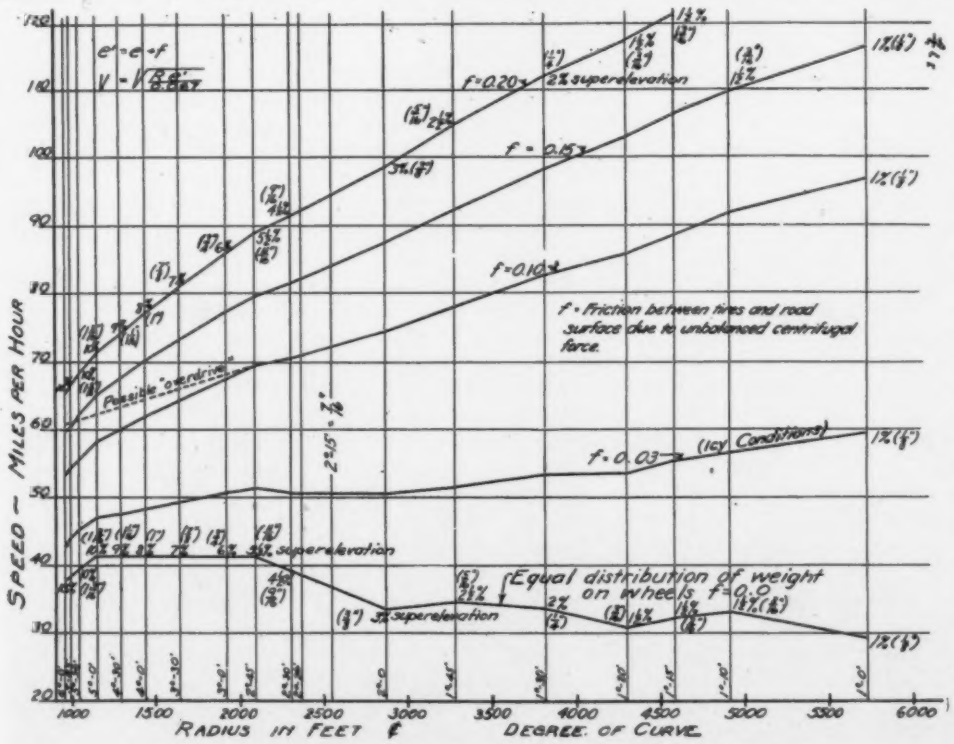

SPEED – MILES PER HOUR
RADIUS IN FEET
DEGREE OF CURVE
f = 0.20
f = 0.15
f = 0.10
f = 0.03
2% superelevation
f = friction between tires and road surface due to unbalanced centrifugal force.
Possible "overdrive"
(Icy Conditions)
(Equal distribution of weight on wheels f = 0.0)

Fig. 5—Curves Employed in the Determination of Super-elevation.

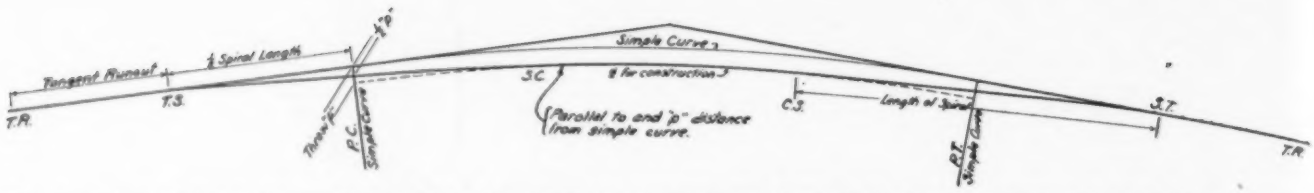


Fig. 6—Spiral Design Diagram That Is Related to Table I. Legend: TR is Point of Tangent Runout; TS Is Point of Tangent Spiral; SC Is Point of Spiral Curve; CS Is Point of Curve Spiral; ST Is Point of Spiral Tangent; PT Is Point of Tangent.

TABLE I.—SUPERELEVATION, SPIRALS AND SIGHT DISTANCE

Degree of Curve Deg. Min.	Normal Rate of Superelevation, Ins. Per Ft.	Desirable Length of Spiral, Ft.	Minimum Length of Spiral, Ft.	Minimum Rear End Collision Sight Distance Required, Ft.	Rear End Collision Sight Distance Obtained Without Widening, Ft[1]	Widening Required for Safe Rear End Collision Sight Distance, Ft.[1]
1 0	1/8	...	...	600	...	..
1 10	3/16	...	...	600	...	..
1 15	3/16	...	...	600	...	..
1 20	3/16	...	...	600	...	..
1 30	1/4	...	...	600	800	..
1 45	5/16	...	...	600	760	..
2 0	3/8	...	...	600	700	..
2 15	7/16	200	...	600	680	..
2 30	9/16	200	200	600	630	..
2 45	11/16	250	230	600	620	..
3 0	3/4	250	250	600	590	..
3 15	13/16	280	270	570	570	..
3 30	7/8	300	290	540	550	..
4 0	1	350	320	475	510	..
4 15	1-1/16	370	350	475	500	..
4 30	1-1/16	370	350	475	485	..
5 0	1-3/16	410	380	475	460	2
5 15	1-3/16	400	370	475	450	3
5 30	1-3/16	400	370	475	430	4
5 45	1-3/16	400	360	475	430	6
6 0	1-3/16	400	350	475	410	7

[1]Based on straight grade and 1:1 cut slopes. Adjust where V.C. is required or other than 1:1 slopes are used. Measured from a point 8 ft. in from inside edge or a total distance of 22.8 ft. to 1:1 slope. Rear end collision sight distance is distance from a point 4.5 ft. above pavement to a point 4 in. above pavement.

slopes or natural growth interferes with normal sight.

In correlating and applying the various minimum requirements, the criterion used was that necessary to secure safe operating conditions under all circumstances. For example, if a vertical curve were designed which would accommodate the required rear end collision sight distance for daylight conditions, this curve must be examined on the basis of headlight sight distance for night driving, and the greater minimum requirement was actually utilized in the design.

The speed on curves of 4 degrees and sharper is largely controlled by the maximum permissible rate of superelevation, in as much as all tests disclose that a maximum rate of superelevation 1 3/16 in. per foot under normal conditions while maximum rate of 1 in. per foot should be used in areas where ice and snow are prevalent on long adverse grades.

Application of Headlamp Sight Distance.—In applying the data on the charts, Figs. 7, 7a, 8, 9, and 10, a certain amount of judgment must be exercised in order that the general design may not become unbalanced. The following outlines certain of these conditions and indicates some of the factors to be weighed before establishing the lengths of vertical curves for head lamp sight distance.

As noted on the charts, the desirable sight distance is 1,000 ft. This has been established because leaders in the automotive headlamp industry state that with properly adjusted headlamps (probably on all but the cheapest vehicles), it is possible to see a white object at a distance of 1,000 ft. today. In view of the fact that these cars are only equipped with headlamps of about ⅓ of the 75,000 beam candle power units permitted by most state laws and particularly because the present trend is toward units of higher intensity, there is a distinct possibility that cars will be equipped with headlamp units, within the next 5 years, that will permit the operator to see dark objects at a distance of 1,000 ft.

However, the application of the 1,000-ft. headlamp sight distance must be limited to conform with other design restrictions such as curvature, cut slopes and illuminated areas. For example, in tangent areas where topographical conditions are such that the motorist will tend to operate at high speeds, it is very desirable to provide 1,000-ft. headlamp sight distance, provided the cost of such provision does not become disproportionate. This is particularly true in sags, where vertical curves of more moderate length will provide the required 1,000 feet. For summits, because of extreme length of the vertical curves required for algebraic difference in grades greater than 3 per cent, it was necessary to limit the sight distance to correspond to a speed of 70 m.p.h. even in localities where high speed may be expected.

Where horizontal curvature is encountered which will impose a limitation on vehicle speed because of the effect of centrifugal force, it is obviously unnecessary to provide headlamp sight distance for a speed in excess of that permitted by such a curve. In order to provide a guide for such cases, a speed diagram, Figure 6, shows the speed at the adopted rates of superelevation for

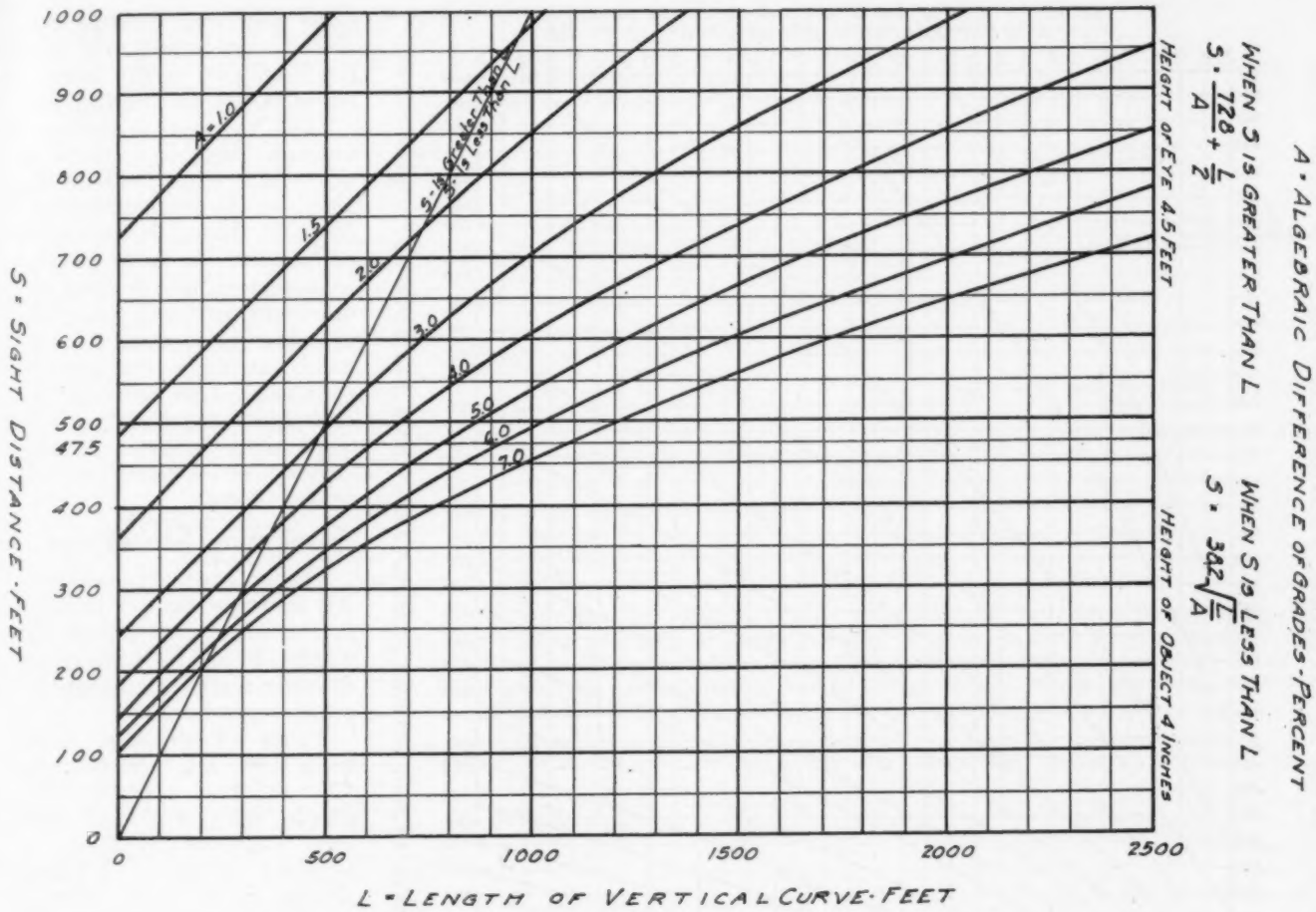


Fig. 7—Daylight Rear End Collision Sight Distance Chart for Vertical Curves.

curves within the range used on the turnpike for various friction values "f." For design purposes the speeds corresponding to the "curve" for a friction value f = 0.10 was used, except that recognition was made of the tendency of operators to "overdrive" the curves sharper than 2° 45′. It is almost certain that under normal weather conditions 90 per cent of all passenger vehicle operators will drive the 6° curves at a speed of at least 60 m.p.h., thus developing a friction value between tires and road surface of 0.15.

Where there is considerable horizontal curvature and where cut slopes restrict daylight vision there does not appear much justification for providing headlamp sight distance for speeds in excess of 70 m.p.h. unless no additional cost or other unfavorable conditions are involved and unless the cut is of such moderate depth that widening of the slope may be feasible in the future. However, it must be recognized that although the cut slope restricts the vision of vehicles traveling in one direction, the vision of vehicles traveling in the opposite direction is not affected so adversely because of the increased lateral distance from such vehicle to the cut slope, except for the limiting effect of the horizontal spill of light from the headlamps. The effect of this latter limitation is shown in Fig. 10.

To summarize:

(a) In long tangent sections in easy country, 1,000 ft. of headlamp sight distance was provided, particularly in sags, and a minimum sight distance for a speed not less than 70 m.p.h. at summits.

(b) Where horizontal curature restricts the speed of the vehicle based on f= 0.10, sight distance to correspond with the speed taken from the speed diagram was provided, except that an allowance was made, where possible, for the tendency to "overdrive" the curves from 2° 45′ to 6°. (See speed diagram Figure 10.)

(c) Where cut slopes restrict the daylight sight distance, no more headlamp sight distance was provided than the actual daylight sight obtained from the more favorable roadway, and taking into account the lateral spill of light from the headlamp. The restricting effect of slopes were not applied, however, where there is a possibility that such slopes may be widened in the future.

(d) Where lateral spill of light from the headlamps limits sight distance around horizontal curves, curvature need not be provided of greater length than necessary to care for such restricted distance.

(e) Where the provision of the indicated sight distance involves disproportionate costs or other unfavorable conditions, complete data respecting the conditions together with an estimate are submitted for consideration of the designers.

It is to be noted that headlamp sight distances are greater than daylight distances. This is due to the fact that the results of several thousands of tests, where the operator was unaware of being subjected to a test, have definitely indicated that the average driver's reaction time is greater at night than during daylight.

How the charts are used in establishing a curve is shown by the following example:

Suppose for example that there is a plus 3 per cent grade intersecting a plus 0.5 per cent grade, resulting in a summit vertical curve. Consulting Fig. 8 and interpolating for an algebraic difference of 2.5 per cent

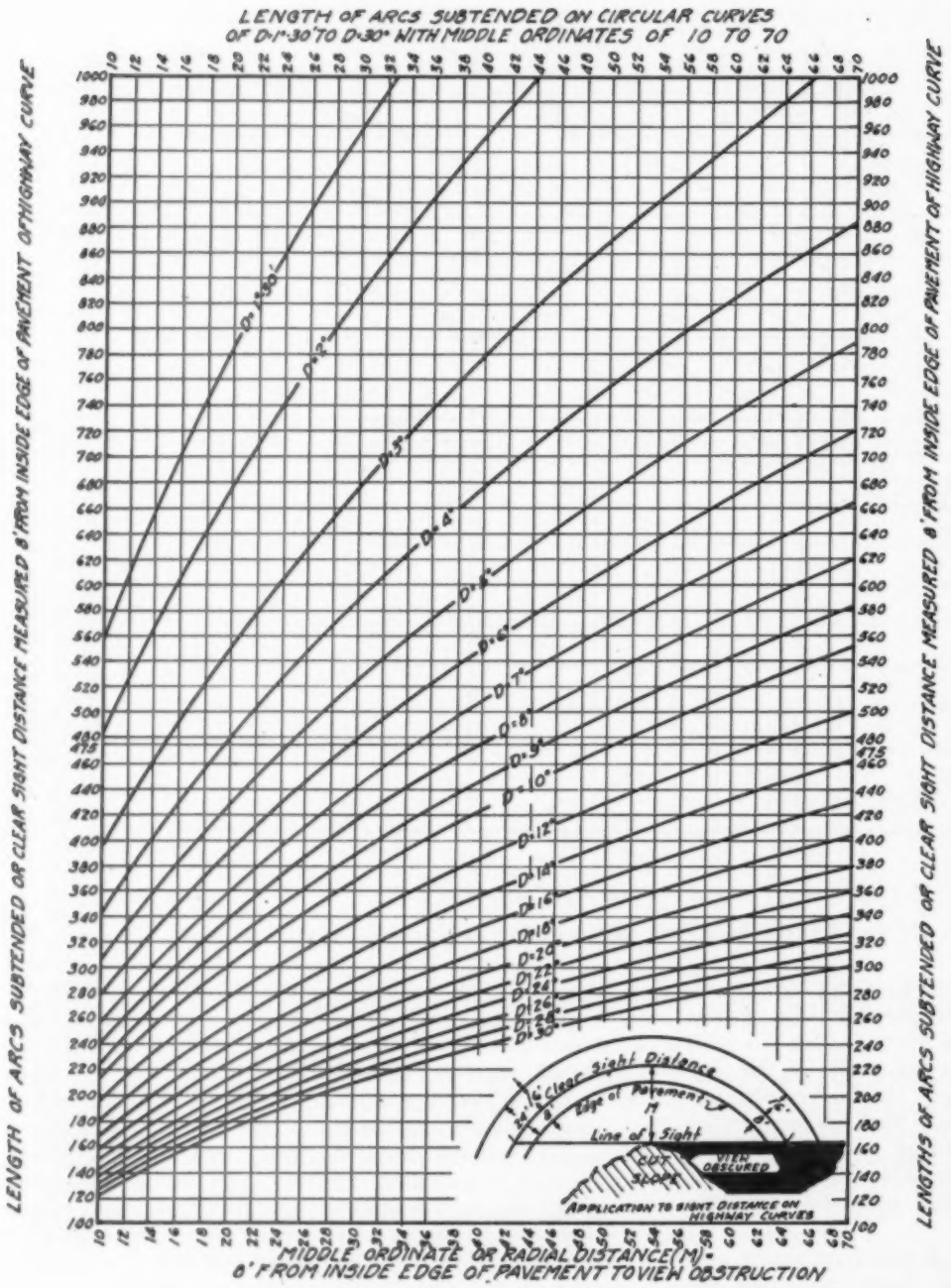


Fig. 7a—Daylight Sight Distance Chart for Horizontal Curves.

for 1,000 ft. sight distance, a vertical curve of 1,550 ft. is found. Upon referring to the highway alignment plan, however, it is found that the vertical curve occurrs on a 2 deg. 30 min. horizontal curve. Consulting Fig. 5, using f = 0.10, a speed of 70 m.p.h. is indicated for this curve. Consequently the vertical curve need not be designed for a speed in excess of 70 m.p.h. Referring to Fig. 8 again, a vertical curve of 830 ft. is found. Upon consulting Fig. 10, however, it is noted that the lateral spread of the headlamp beam on a 2 deg. 30 min. curve will permit vision for only 600 ft. Returning to Fig. 8 again and using 600 ft. sight distance (on algebraic difference of 2.5 per cent) a vertical curve 560 ft. long is found. Referring now to Table I it is found that a minimum rear end collision sight distance (daylight) of 600 ft. is required for a 2 deg. 30 min. curve. Consulting Fig. 7 (sight distance 600 ft., algebraic difference 2.5 per cent) a vertical curve 600 ft. long is found. Consquently a 600 ft. vertical curve would be used, because this is the limiting condition. Incidentally 600 ft. is the minimum length vertical curve in use on the turnpike.

Upon referring to the speed diagram, Fig. 5, it is to be noted that with f = 0.03 the speed on ice for curves of 3° 30′ and flatter, is 50 m.p.h. or greater. It is of interest to note that the distance required to react and stop a car on glaze ice at a speed of 50 m.p.h. at night will average 1,050 ft. This indicates the desirability of providing adequate sight distances, particularly where ice conditions will be a problem.

Designing Structures

There are approximately 300 bridge structures included in the turn pike project, of which 140 are for purposes of drainage and the remainder for grade separations.

Types of drainage structures used are arches under fill, reinforced concrete slabs, simple span reinforced concrete T-beams, continuous reinforced concrete T-beams, simple span steel I-beams, continuous steel I-beams, and a very few reinforced concrete box culverts.

The alignment of the turnpike is such that only a very few streams of any magnitude are encountered, therefore, most of the structures are of short spans. All of the drainage structures are designed to have sufficient waterway opening for 100 per cent of the maximum anticipated run-off. Because of the roadway width, even structures of small span represent a considerable expenditure and it was therefore necessary to give unusual consideration to economies in design. Due to the high fills occurring in the valleys, long arch culverts supporting heavy loads were encountered. The most notable of these arches is the twin span structure over Clear Creek in Bedford County. This structure consists of two spans of 52 ft. clear each, is 305 ft. in length, and has a fill of 70.5 ft. over the crown. It contains in excess of 8000 cu. yds. of concrete. In all, there are approximately 80 of these arch structures ranging in size from the Clear Creek arch down to a culvert of 6 ft. span approximately 90 ft. long. A small difference in area of cross-section represents considerable difference in quantity when the long lengths are considered.

There are approximately 20 drainage structures of reinforced concrete T-beam design of which 8 are multiple spans. These structures range in size from a single span of 20 ft. to three spans of 45 ft. each. Special

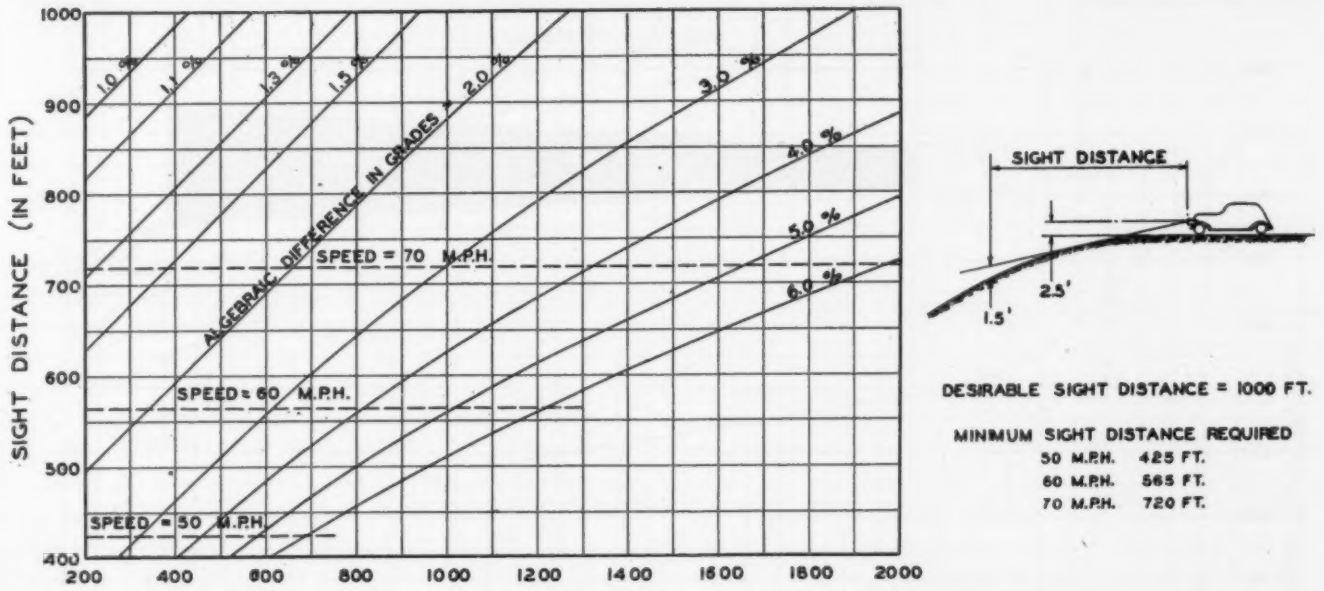


Fig. 8—Minimum Length of Vertical Curves on Summits (in feet). Notes to Accompany the Chart: (a) Provide 1,000-Foot Headlamp Sight in Easy Country on Tangent Sections at Sags, and Minimum Sight for a Speed of 70 MPH at Summits. (b) Check Speed on Horizontal Curves for Speed Based on f = 0.10 and Limit Headlight Sight to Such Speed. (c) Check Effect of Cut Slopes and Adjust Headlamp Sight Accordingly. (d) Check Effect of Horizontal Spread of Light on Horizontal Curves and Adjust Headlamp Sight Accordingly.

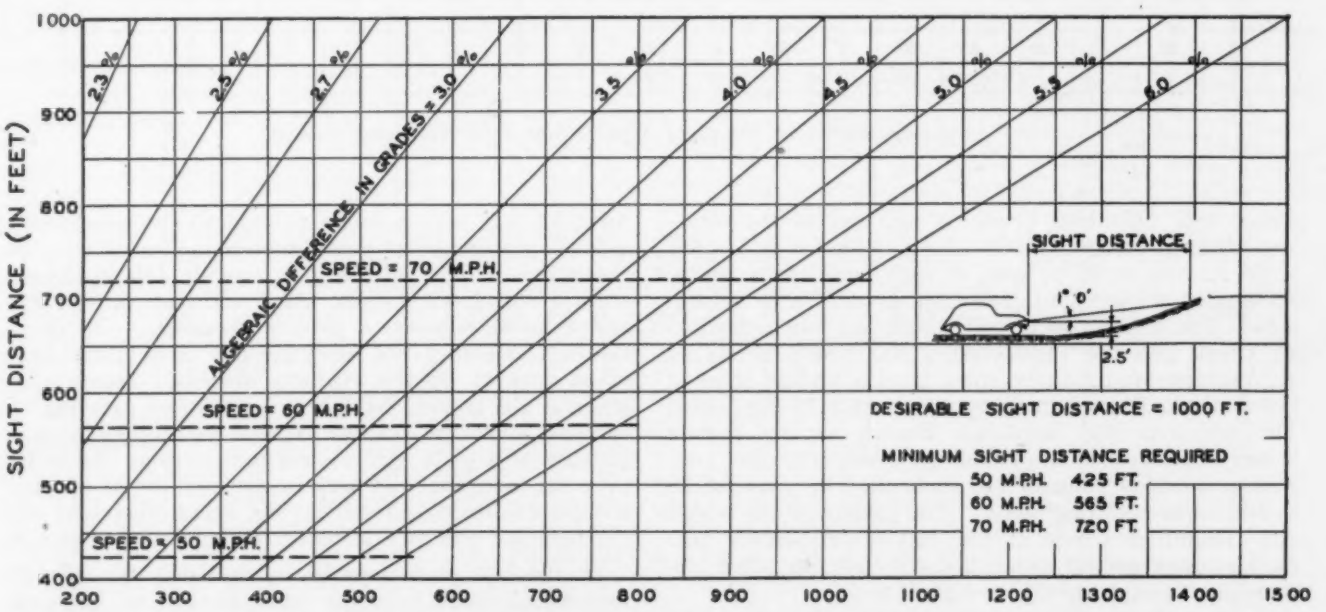


Fig. 9—Minimum Length of Vertical Curves in Sags (in Feet). Notes to Accompany the Chart: (a) Provides 1,000-Foot Headlamp Sight in Easy Country on Tangent Sections at Sags, and Minimum Sight for a Speed of 70 MPH at Summits. (b) Check Speed on Horizontal Curves for Speed Based on f = 0.10 and Limit Headlight Sight to Such Speed. (c) Check Effect of Cut Slopes and Adjust Headlamp Sight Accordingly. (d) Check Effect of Horizontal Spread of Light on Horizontal Curves and Adjust Headlamp Sight Accordingly.

study was given to the curbs and parapets (rails) on these structures which resulted in a design consisting of a double curb topped by a comparatively thin and simple parapet. It was felt that the parapets should be as inconspicuous as possible and the design finally selected emphasizes this characteristic. The double curb is so designed that if a passenger car strikes the lower curb, neither its fender nor any other part of its body can foul the upper curb, whereas, should a truck strike the lower curb, the setbacks of the upper curb and parapet are such that the overhanging body cannot foul the parapet.

The largest continuous I-beam structure is that over the Conodoguinet Creek, Cumberland County. This bridge has 3 spans of 69 ft. each. The curb and parapet design used on the I-beam structures is identical to that used on the T-beam bridges.

There are 4 continuous plate girder bridges. The largest of these is that over the Raystown Branch of the Juniata River near Bedford. This structure has a continuous girder unit consisting of a middle span of 125 ft. flanked by 100 ft. spans with 6 spans of continuous I-beams at one end varying in length from 40 ft. to 50 ft. The total length of bridge is approximately 590 ft. This structure is built on a 2 deg. curve extending throughout its entire length. The continuous girder

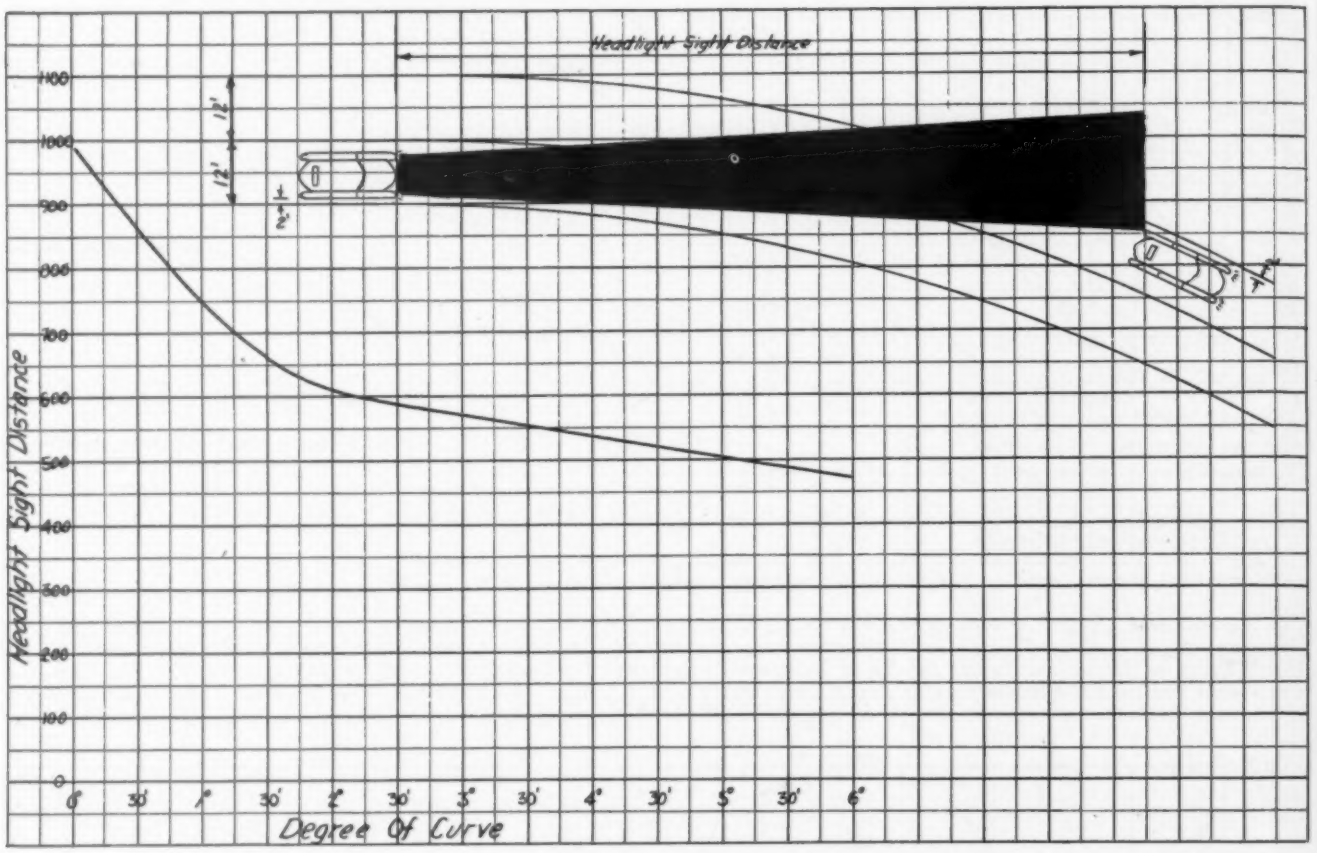


Fig. 10—Application of Headlight Sight Distance to Horizontal Curves.

bridge over Dunnings Creek ½ mi. west of the Raystown Branch bridge is 480 ft. long, made up of 4 spans of 96 ft. with a 48 ft. span at each end. This bridge is continuous over 5 supports and is built on a 60 deg. skew. The continuous girder bridge over Little Sewickley Creek and the Pennsylvania Railroad near Arona in Westmoreland County consists of a middle span of 110 ft. flanked by 65 ft. spans and is on a 25 deg. skew. The one over the Raystown Branch of the Juniata River, 8 mi. west of the Dunnings Creek structure, consists of a middle span of 110 ft. flanked by spans of 76 ft. and is on a 45 deg. skew. The girders of the bridge over Dunnings Creek at the Raystown Branch near Bedford have curved bottom flanges while the other two structures have parallel chord girders.

Perhaps the most imposing structure along the entire turnpike is that over Little Sewickley Creek, the Pennsylvania Railroad, and State Highway Route 119 near New Stanton, Westmoreland County. The main span of this structure is a 170 ft. clear span open spandrel reinforced concrete arch. The main arch span is flanked at each end by two spans of 82 ft. each adjacent to the arch, and a single span is a reinforced concrete rigid frame of a rib type. The spans either side of this rigid frame are reinforced concrete T-beams restrained at the rigid frame end and freely supported at the opposite end. This structure has a total length of 600 ft., is on a 2 deg. 30 min. curve throughout its entire length and carries, in addition to the normal turnpike roadway, an accelerating lane from the adjacent New Stanton interchange. The roadway is superelevated and is on a constant 3 per cent grade.

The grade separation problem was large since approximately 180 state and township roads intersect the turnpike. It was possible to relocate or vacate only a small percentage of these intersecting roads with the result that it was necessary to provide 140 grade separation structures. There are 5 railroads, one trolley, and a small number of private crossings. All of the railroad crossings are undergrades, 3 of them being taken care of by the viaducts described above. The other 2 are crossed by I-beam structures carrying the turnpike over the tracks. The single trolley crossing consists of a plate girder structure carrying the trolley over the turnpike. By way of explanation an overhead structure is one which carries the intersecting road over the turnpike and vice versa for an underpass structure.

Of the 140 grade separations provided, 80 carry the intersecting road over the turnpike and 60 carry the turnpike over the intersecting road. The structures provided for the undergrade crossings are reinforced concrete T-beams designed similar to those provided for drainage structures. About 20 more structures are for interchanges, railroad and trolley, and private crossings.

The reinforced concrete rigid frame of solid deck type was adopted for intersecting roads. This type has additional advantage in the fact that it lends itself to a very pleasing esthetic treatment without great cost. Fifty-two of these structures are included in the project. Of these, 6 occur at interchanges where the turnpike is carried over the ramps, and are of shorter span than those carrying the intersecting roads over the turnpike. These structures all have a span of 78 ft. clear, normal to the abutments, and occur with skews ranging from 0 deg. to 30 deg. The roadway width of these structures is, in general, 20 ft. curb to curb with a few 22 and 24 ft.

(*Continued on page 67*)

To Washington, Pa. & Wheeling, W.Va.
To St. Louis &
Chicago
To New Castle &
Youngstown
Route 30 - West
To Cleveland
Route 22 - West
To St. Louis

ISSUED BY

PENNSYLVANIA TURNPIKE COMMISSION

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CHAIRMAN

MEMBERS OF COMMISSION
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FRANK BEBOUT
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I. LAMONT HUGHES (EX-OFFICIO)

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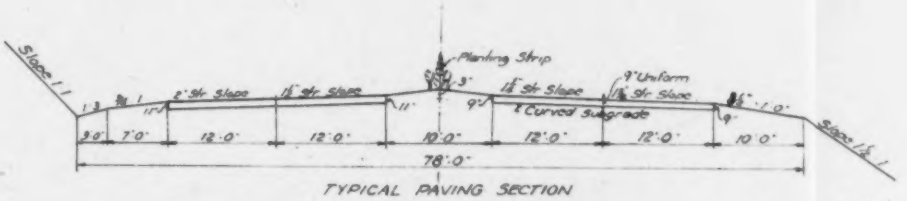

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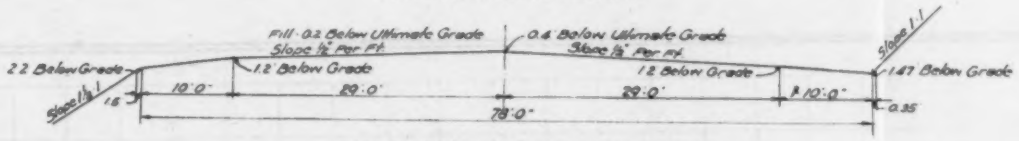
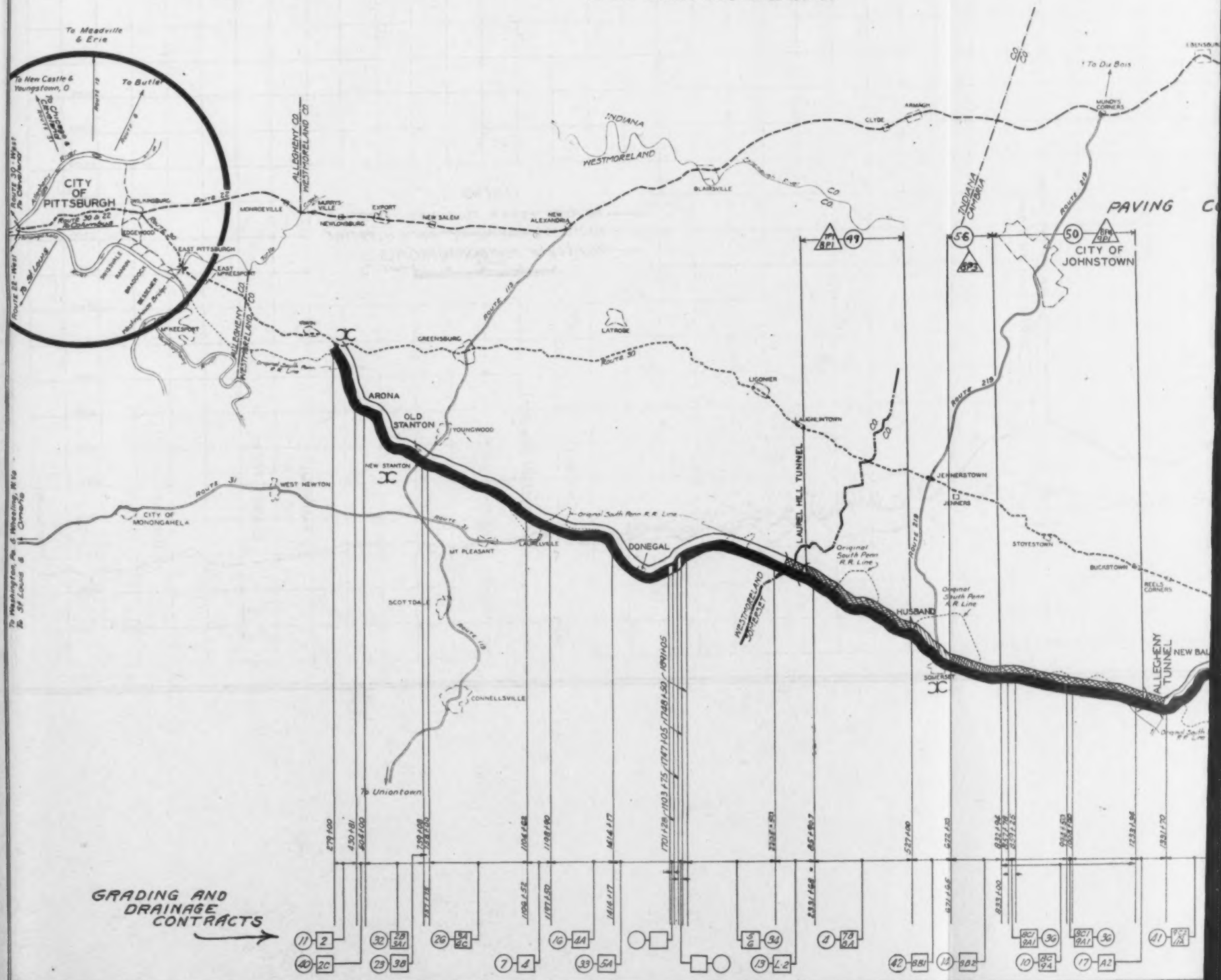


TYPICAL GRADING AND DRAINAGE SECTION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Route 30 & 22 To Columbus
Route 22 - West To St. Louis
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Route 19
Route 8
WILKINSBURG
EDGEWOOD
EAST PITTSBURGH
WILMERDING
TURTLE CREEK
BRADDOCK
BRADDOCK HILLS
BELLEVUE
Edgewood-Swissvale Bridge
McKEESPORT
ALLEGHENY CO.
WESTMORELAND CO.
MONROEVILLE
MURRYSVILLE
NEWLOYSBURG
EXPORT
NEW SALEM
NEW ALEXANDRIA
INDIANA
WESTMORELAND
ALLEGHENY CO.
WESTMORELAND CO.
BLAIRSVILLE
Pennsylvania Turnpike
CLYDE
ARMAGH
INDIANA
CAMBRIA
To Du Bois
MUNDYS CORNERS
Route 219
PAVING C
56
SR3
50
SR 160
CITY OF JOHNSTOWN
Route 119
GREENSBURG
LATROBE
LIGONIER
LAUGHLINTOWN
ARONA
OLD STANTON
YOUNGWOOD
NEW STANTON
Route 30
Route 31
WEST NEWTON
CITY OF MONONGAHELA
To Washington, Pa. & Wheeling, W. Va.
To St. Louis & Omaha
Original South Penn R.R. Line
MT. PLEASANT
LAUREL HILL TUNNEL
JENNERSTOWN
JENNERS
STOYESTOWN
BUCKSTOWN
REELS CORNERS
Original South Penn R.R. Line
HUSBAND
SCOTTDALE
Route 119
CONNELLSVILLE
DONEGAL
WESTMORELAND EXPRESSWAY
SOMERSET
ALLEGHENY TUNNEL
NEW BAL
To Uniontown
Original South Penn R.R. Line
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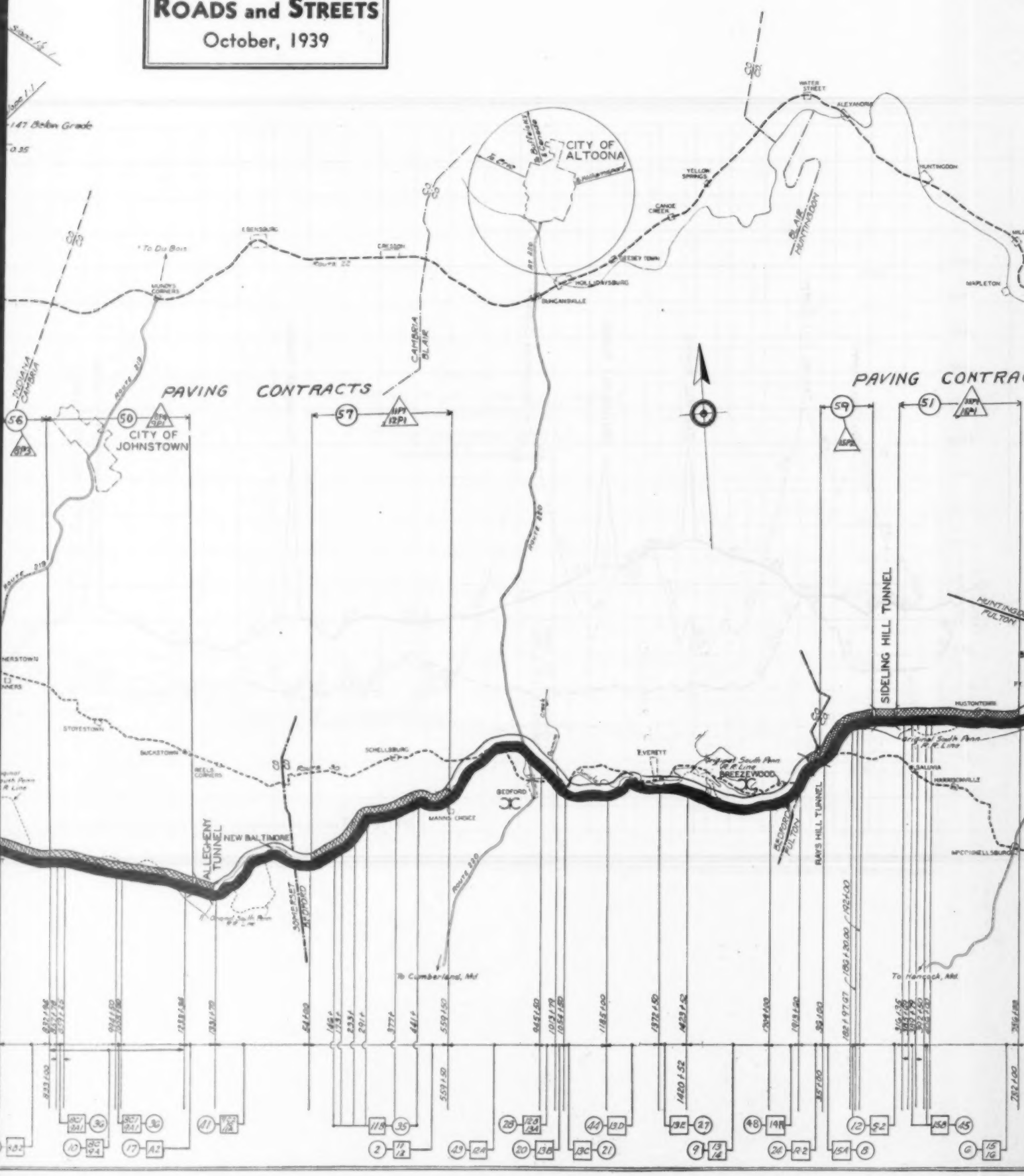

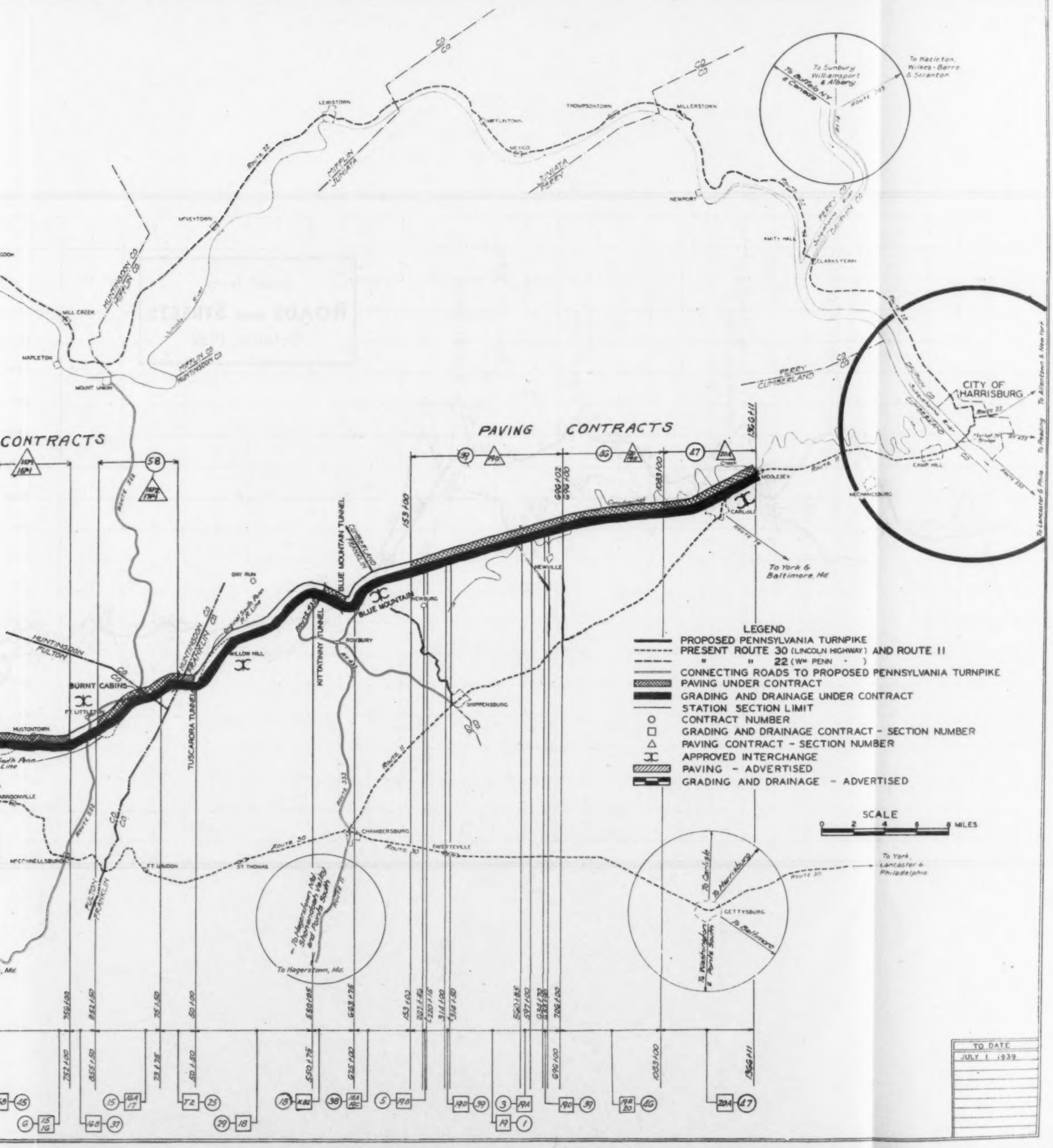
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JUNIATA FERRY
PERRY CUMBERLAND
PERRY DAUPHIN
DAUPHIN CUMBERLAND
CUMBERLAND FRANKLIN
HUNTINGDON MIFFLIN
HUNTINGDON FULTON
FULTON FRANKLIN
MIFFLIN HUNTINGDON
MARLETON
MOUNT UNION
MILL CREEK
MCVEYTOWN
BURNT CABINS
FT LITTLETON
HUSTONTOWN
BLUE MOUNTAIN
NEWBURG
ROXBURY
SHIPPENSBURG
WILLOW HILL
KITTATINNY TUNNEL
TUSCARORA TUNNEL
BLUE MOUNTAIN TUNNEL
CHAMBERSBURG
FAYETTEVILLE
ST THOMAS
FT LOUDON
MCCONNELLSBURG
NEWVILLE
MECHANICSBURG
CAMP HILL
MIDDLESEX
CARLISLE
GETTYSBURG
CITY OF HARRISBURG
To Sunbury Williamsport & Albany
To Buffalo N.Y. & Canada
To Hazleton, Wilkes-Barre & Scranton
To York & Baltimore, Md
To Hagerstown, Md. Shenandoah Valley and Points South
To Carlisle
To Harrisburg
To Baltimore
To Washington & Points South
To York, Lancaster & Philadelphia
To Allentown & New York
To Reading
To Lancaster & Phila
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CITY OF HARRISBURG
To Allentown & New York
To Reading
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PRESENT ROUTE 30 (LINCOLN HIGHWAY) AND ROUTE 11
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APPROVED INTERCHANGE
PAVING - ADVERTISED
GRADING AND DRAINAGE - ADVERTISED
SCALE
0 2 4 6 8 MILES
TO DATE
JULY 1 1939

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PENNSYLVANIA TURNPIKE COMMISSION

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CHAIRMAN

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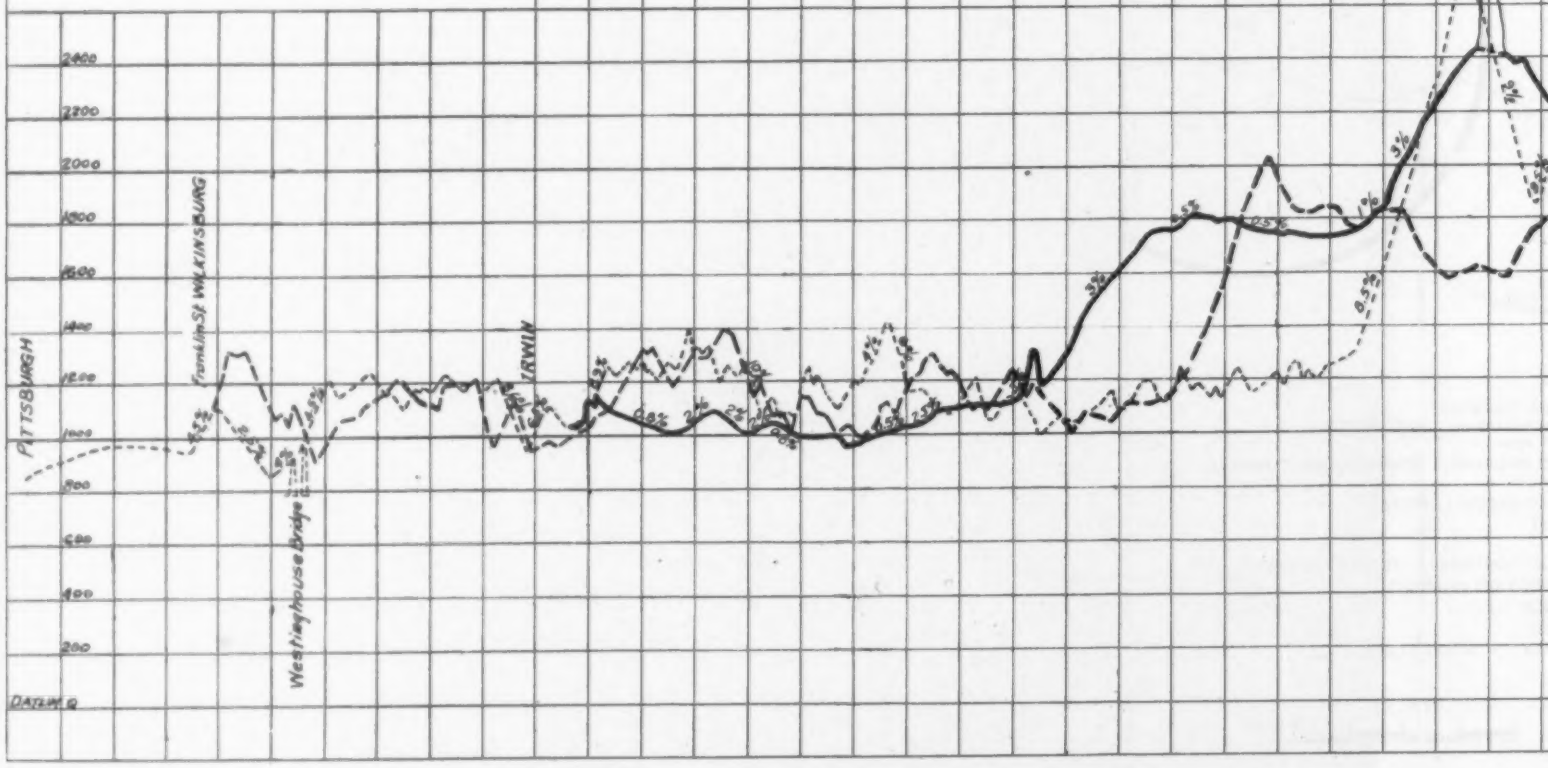

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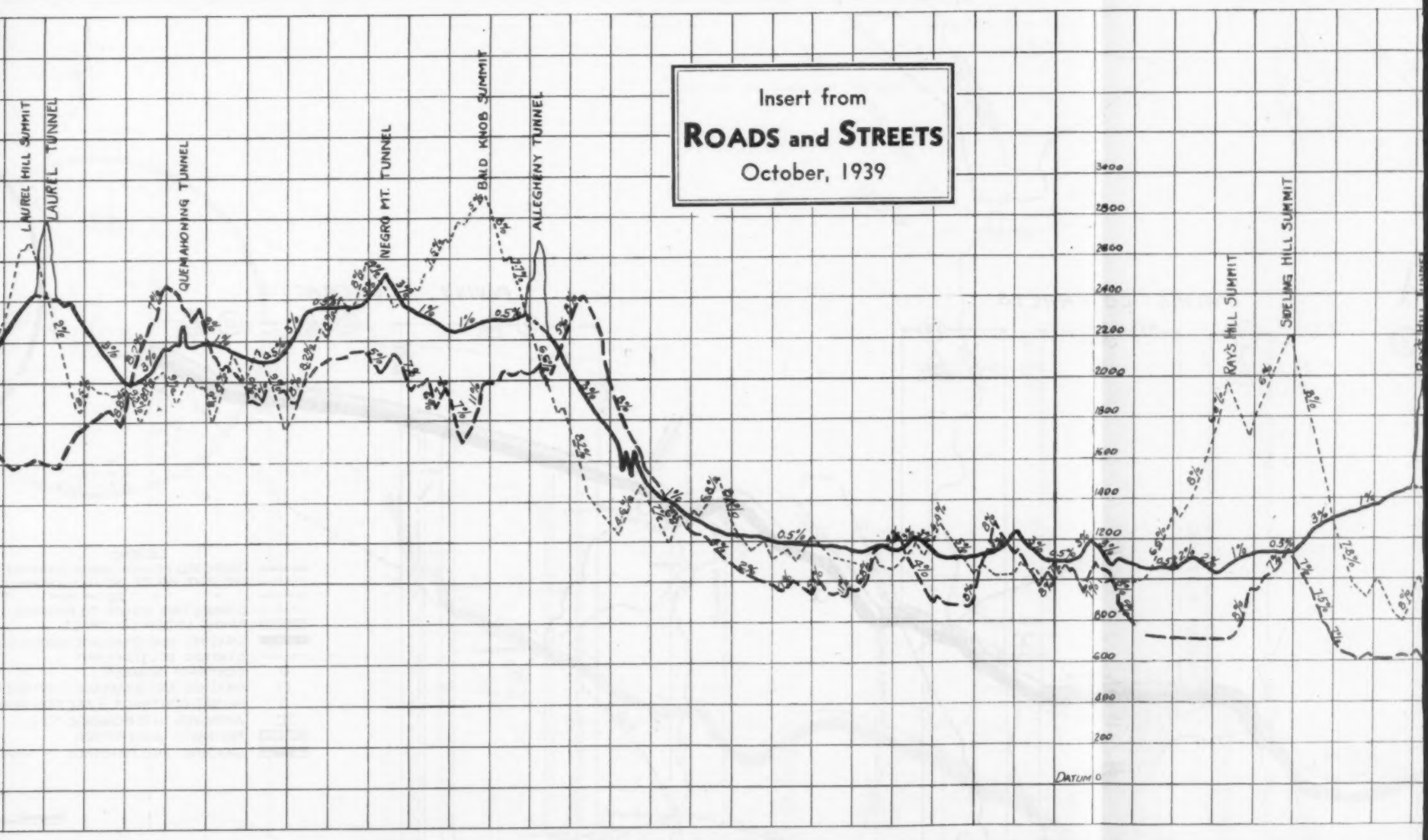
ROADS and STREETS

October, 1939



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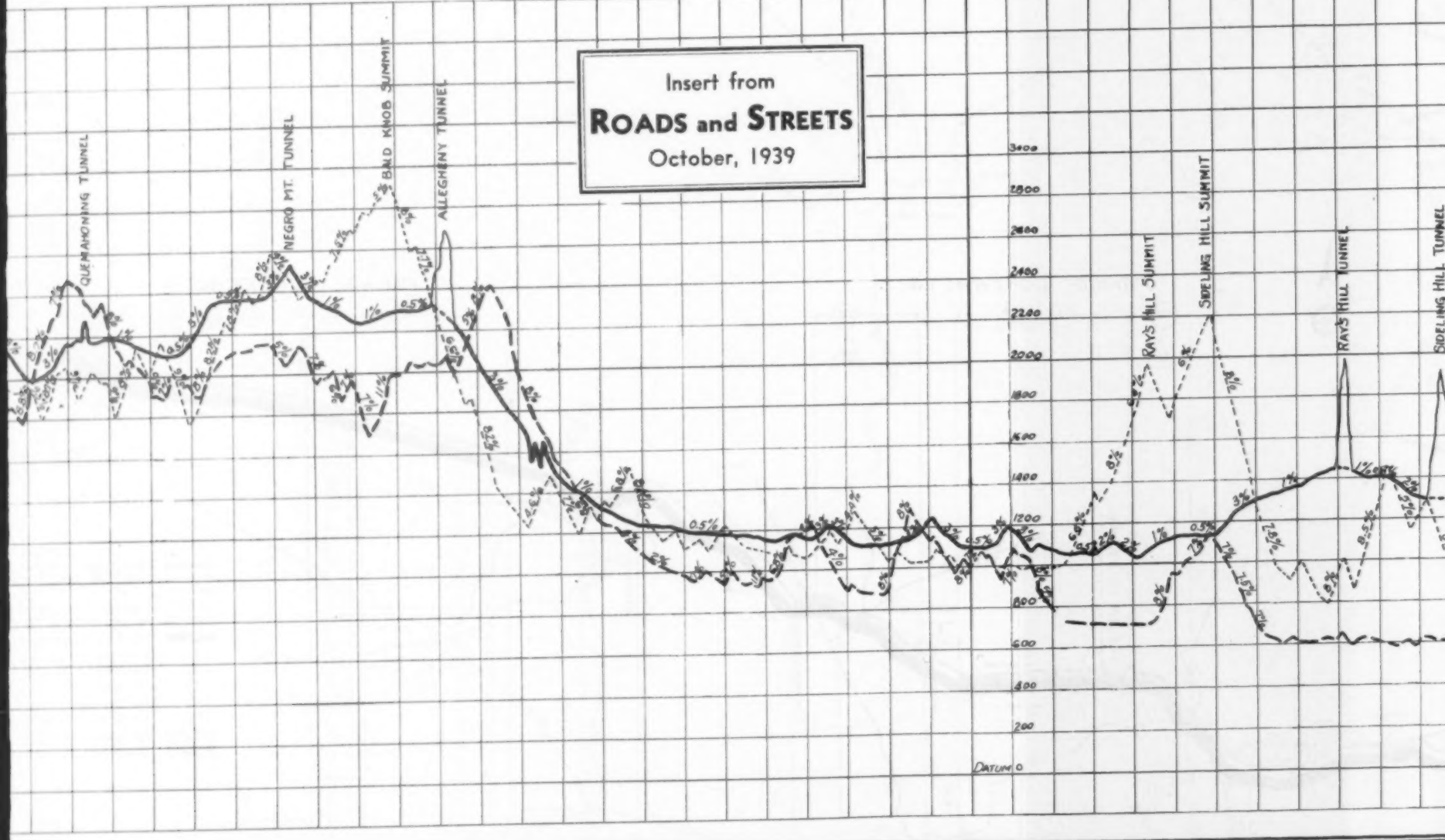
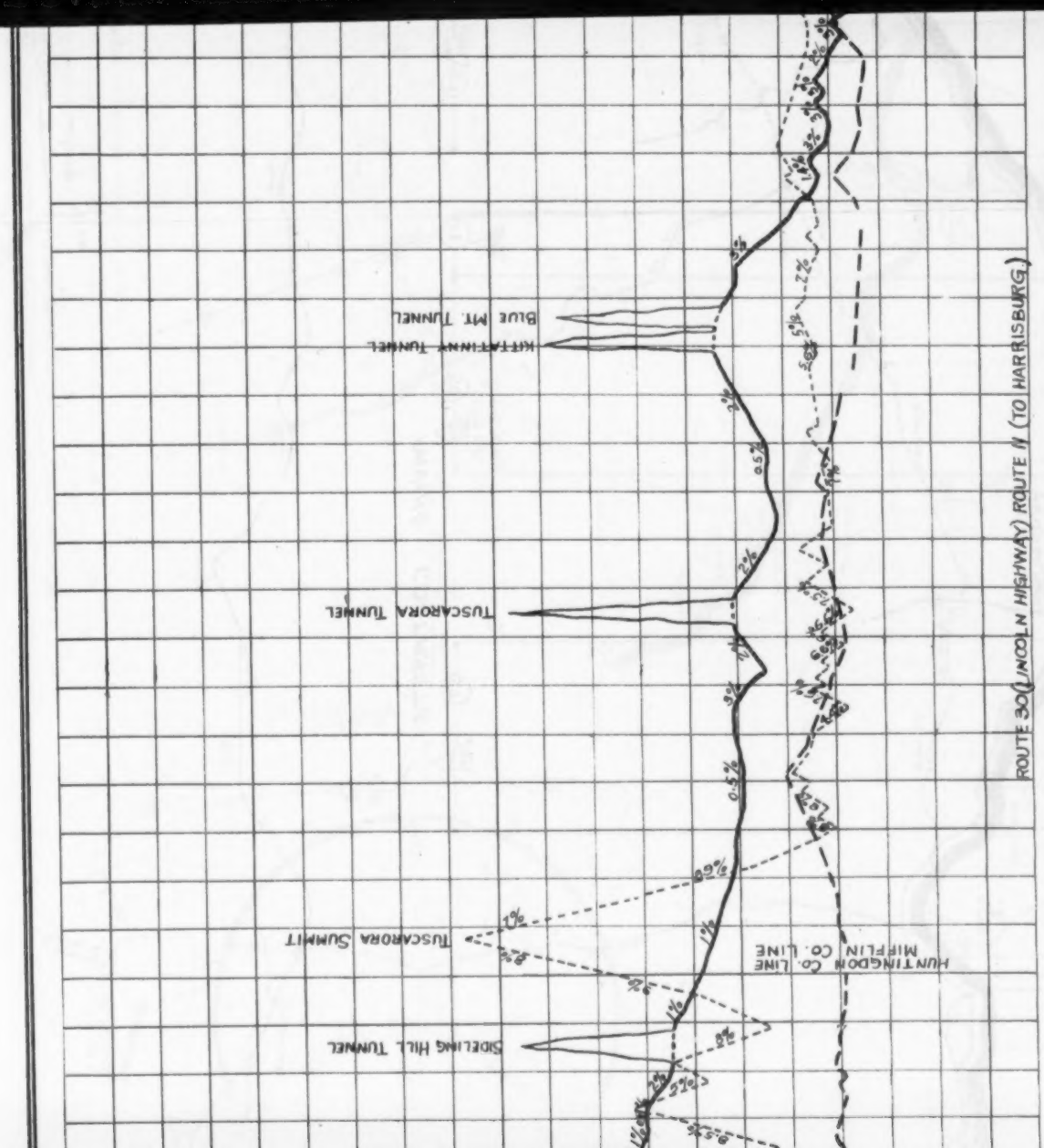
October, 1939

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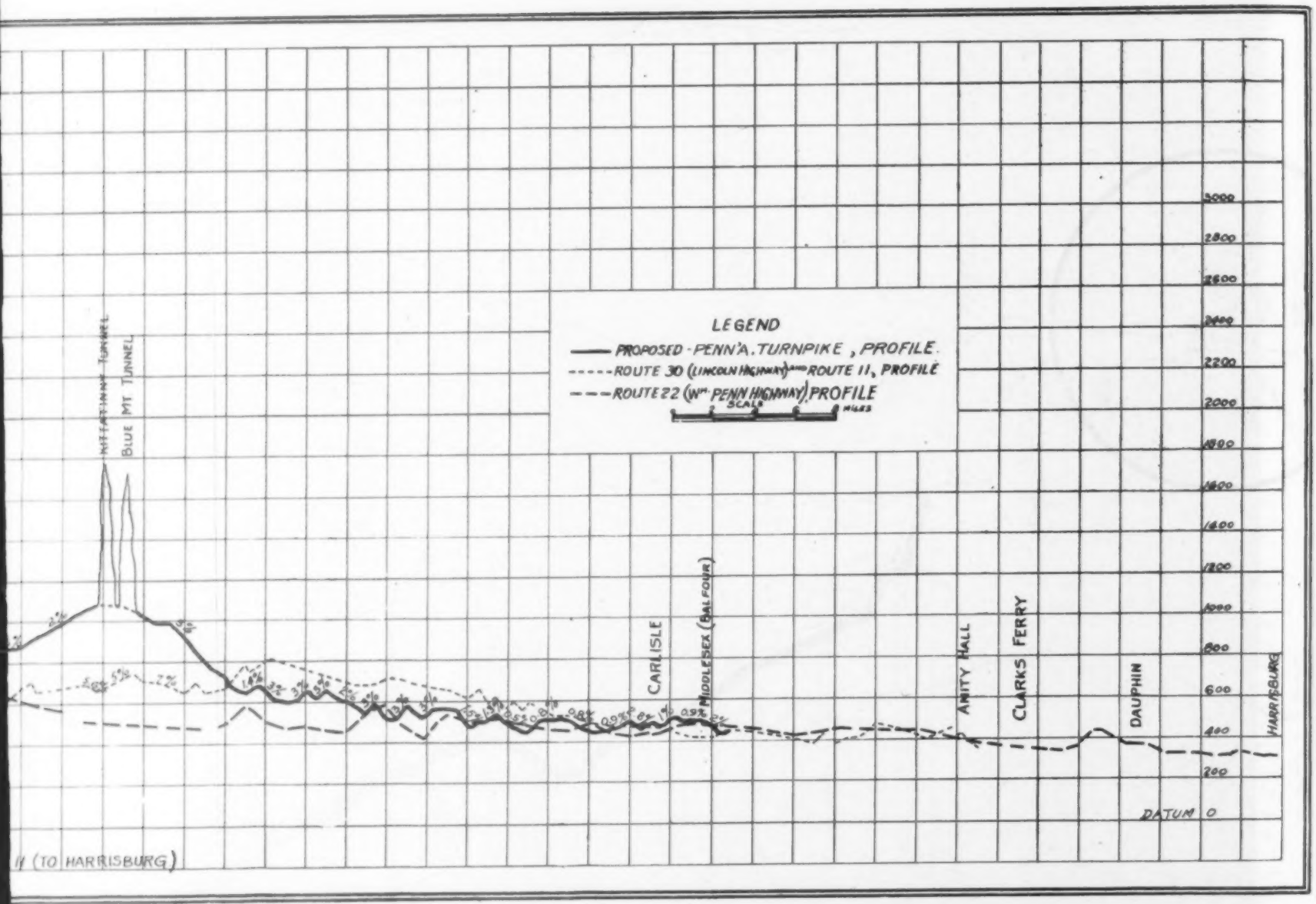
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ADVERTISING PAGES REMOVED

EDITORIAL

CONTINUE THE TURNPIKE

COMMENDABLE. That's just the word to apply to that superhighway project known as the Pennsylvania Turnpike. The writer has driven between the points that are the present termini of the turnpike so often that he realizes the value of extending this project both east and west.

It should be continued east to a point in the vicinity of Philadelphia where connection should be made to a similar superhighway from Boston to Richmond. Likewise, and just as important, should be a continuation to the north of Pittsburgh, extending across Ohio to a point in the environs of Chicago. America needs these roads. Let's not stop now.

The writer is well aware of the report by the Public Roads Administration on "Toll Roads and Free Roads." Recommendations contained therein are based on the findings of the statewide planning surveys and are approached from the economic viewpoint. If economics were to be the guiding factor in the promulgation of the Union Pacific project across the plains of the West, or of the Southern Pacific, those railroads would never have been built. Economics alone will not suffice to justify a superhighway. Vision and foresight are necessary also. Improved transportation facilities have always caused agricultural and industrial growth. Give superhighways a chance. Continue the turnpike west. Continue it east, and build another from Boston to Richmond.

▼

DIG, LOAD, AND RUN

WERE you a witness of the Florida boom of 1924-25 and 26? Did you see the Mississippi highway boom of 1936-37? If not, you should visit the Pennsylvania Turnpike and get imbued with the spirit of rush, push, and tempo of that project.

One day as I was inspecting the grading work I came to a very rough rock dump that required me to travel slowly or break up my car. Behind me I saw through my rear-vision mirror a contractor's pickup truck following me. As I nosed over the rough dump I selected what I considered to be the smoothest part of the rough rock fill. The contractor's truck driver pulled up behind me and tooted his horn for me to move faster. He was so accustomed to racing from one place to the next that I was obstructing his travel.

Speed seems to be the desire of the contractors on the turnpike. Time is pressing them and they are pressing the job. Dirt and rock are flying, not in airplanes, but in large quantities from cut or borrow to fill. Were I to venture a prophecy I would say that the Pennsylvania turnpike project is a proving ground for faster units of large capacity.

Some contractors are working three 8-hour shifts, others, three 7-hour shifts, while others have massed enough equipment to keep up to schedule with only one 8-hour shift. Load fast, haul fast, dump fast, get out and get another load. That's the tempo on the turnpike.

SET HIGH SIGNING STANDARD

NO matter how much safety is designed into a highway, signs will still be indispensable. In the writer's opinion, and he travels thousands of miles each year on the highways of the country, signs for the Pennsylvania turnpike should set a high standard. Traveling as the writer does, he recognizes the need for duplicate signs separated by a distance of two or three hundred feet. Sign words and letters should be larger than those now commonly in use because the higher rates of speed to be traveled will give less time for perception.

If a sign serves a purpose at all, it should be as readily visible at night as during the day. Consequently all signs on and approaching the turnpike should be reflectorized.

Undoubtedly the commission will erect directional signs at all important junctions on U. S. and State numbered highways, north as far as U. S. 20 and south along U. S. 40.

It is the writer's opinion that acceleration and deceleration lanes should be signed at about 200 foot intervals in such a way as to notify drivers that their speeds should be of the order specified on the signs. Since the commission is subject to suit for damages it is evident that proper and complete signing is mandatory.

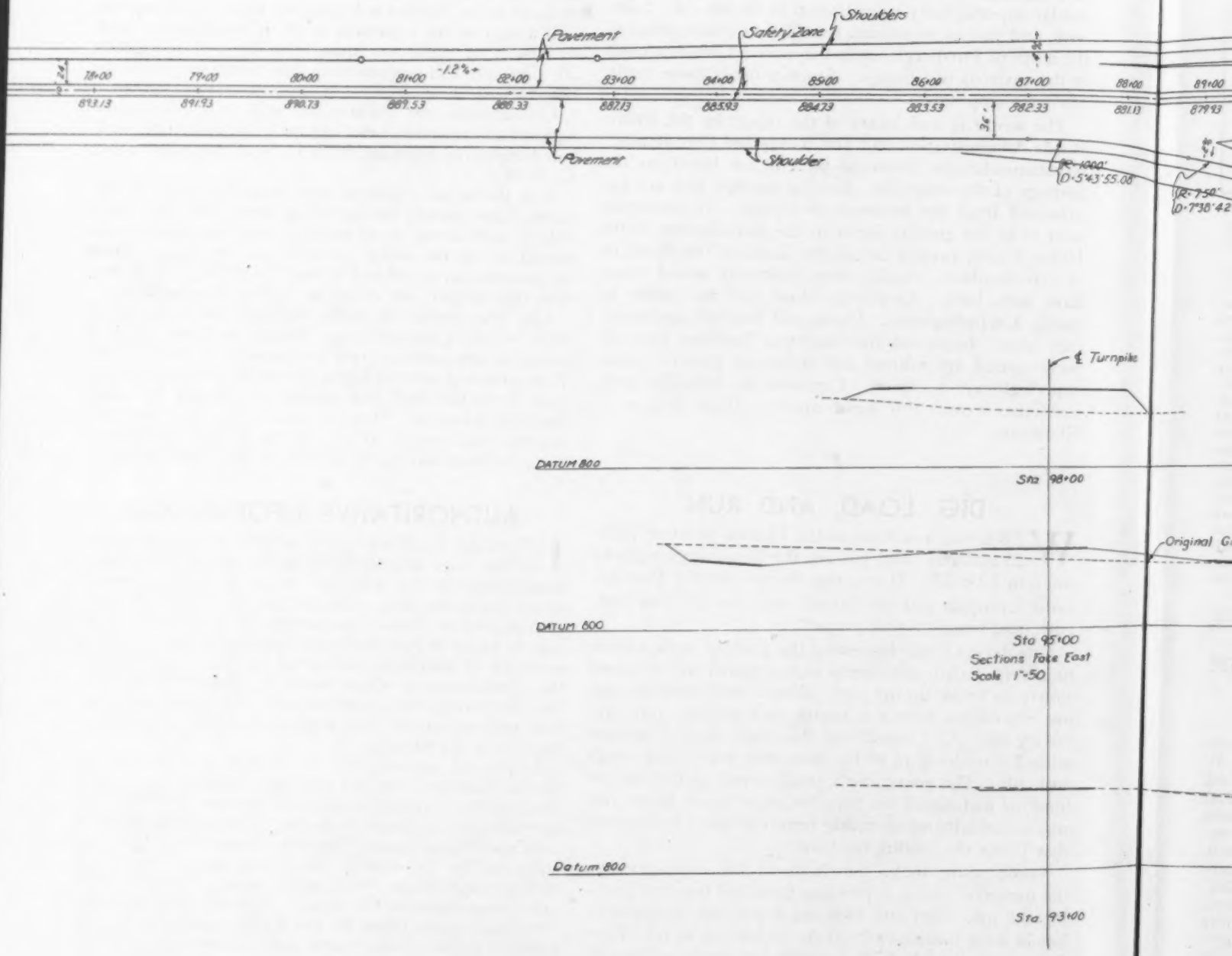
Like the system of traffic lighting above the roadways of the Queensborough Bridge in New York, it would be advisable to treat the tunnels of the turnpike. This system of colored lights should be on a circuit separate from the high line source of supply for other electrical demands. Then in cases of failure of the normal electrical supply drivers in the tunnels will have a guide without having to resort to their headlights.

▼

AUTHORITATIVE INFORMATION

INFORMATION on the Pennsylvania turnpike given in this issue was obtained at the offices of the commission and on the job. The writer spent three weeks steady gathering data, with the able assistance of turnpike engineers. Before the manuscript was sent to Chicago to be set in type, individual parts of it were read for accuracy of statement and detail by those engineers of the commission to whose work the discussion applied. In other words, this presentation is the latest authoritative information on the engineering and construction features of the turnpike.

There will, undoubtedly, be changes in a few of the details of design. That is a normal procedure. It is doubly more liable to occur in this case because five different agencies have a "finger in the pie." The designs originate with the Pennsylvania Turnpike Commission. They are submitted for approval to the Pennsylvania Department of Highways. Since PWA money was granted, this federal agency reserves the right of inspection and approval. The bonds were taken by the RFC, so another federal agency's engineers, attorneys, and administrative officers also reserve the right of inspection and approval. The RFC sold the bonds through a New York bond house and for some non-understandable reason they demand a voice of approval on all plans. They employed a firm of consulting engineers to represent them. Each of these agencies naturally, it is supposed, want to be the "Little Jack Horner" to say "See what a big boy am I." Result? Confusion and delay. Yet, the job is proceeding on schedule in spite of it all.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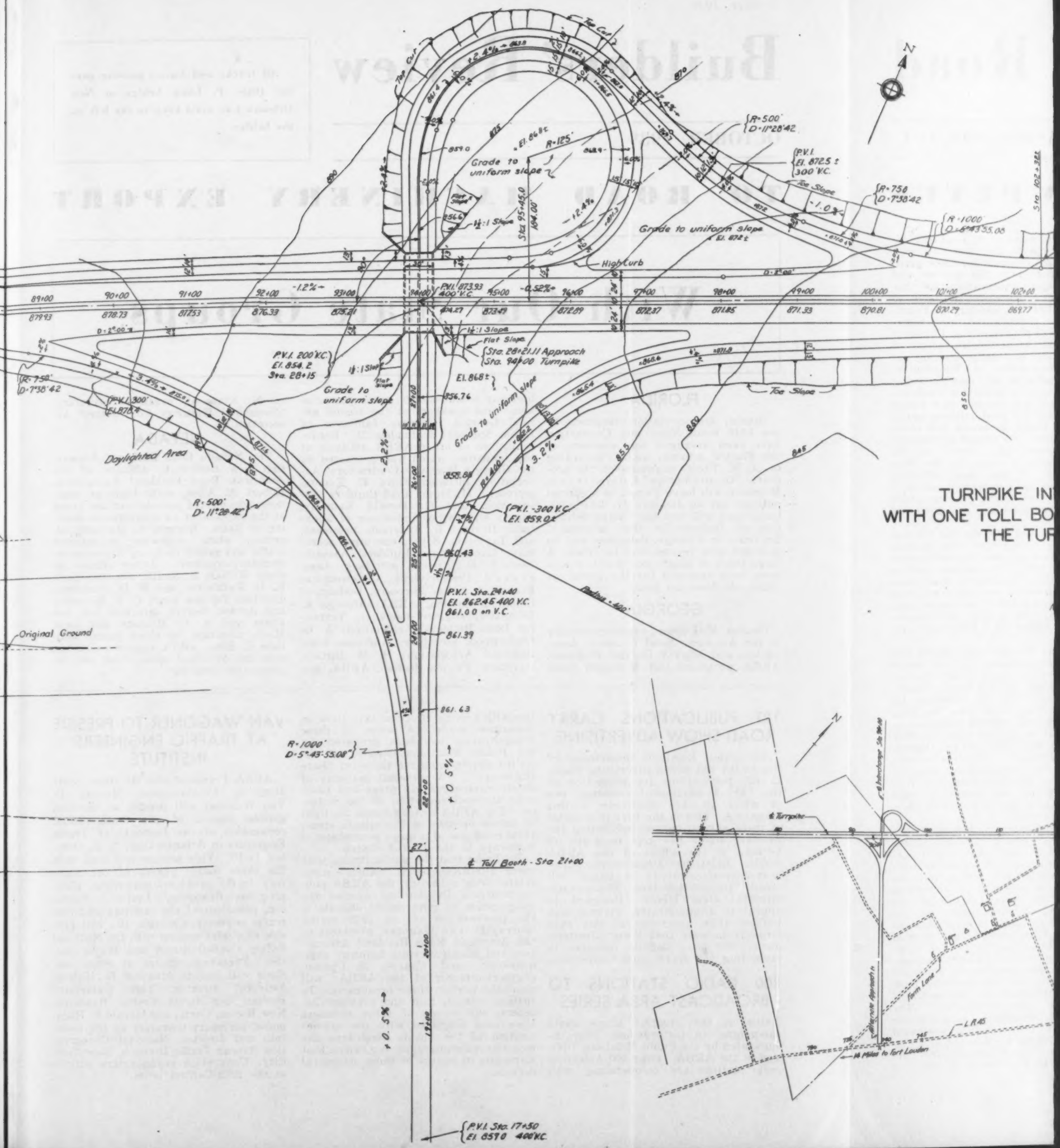
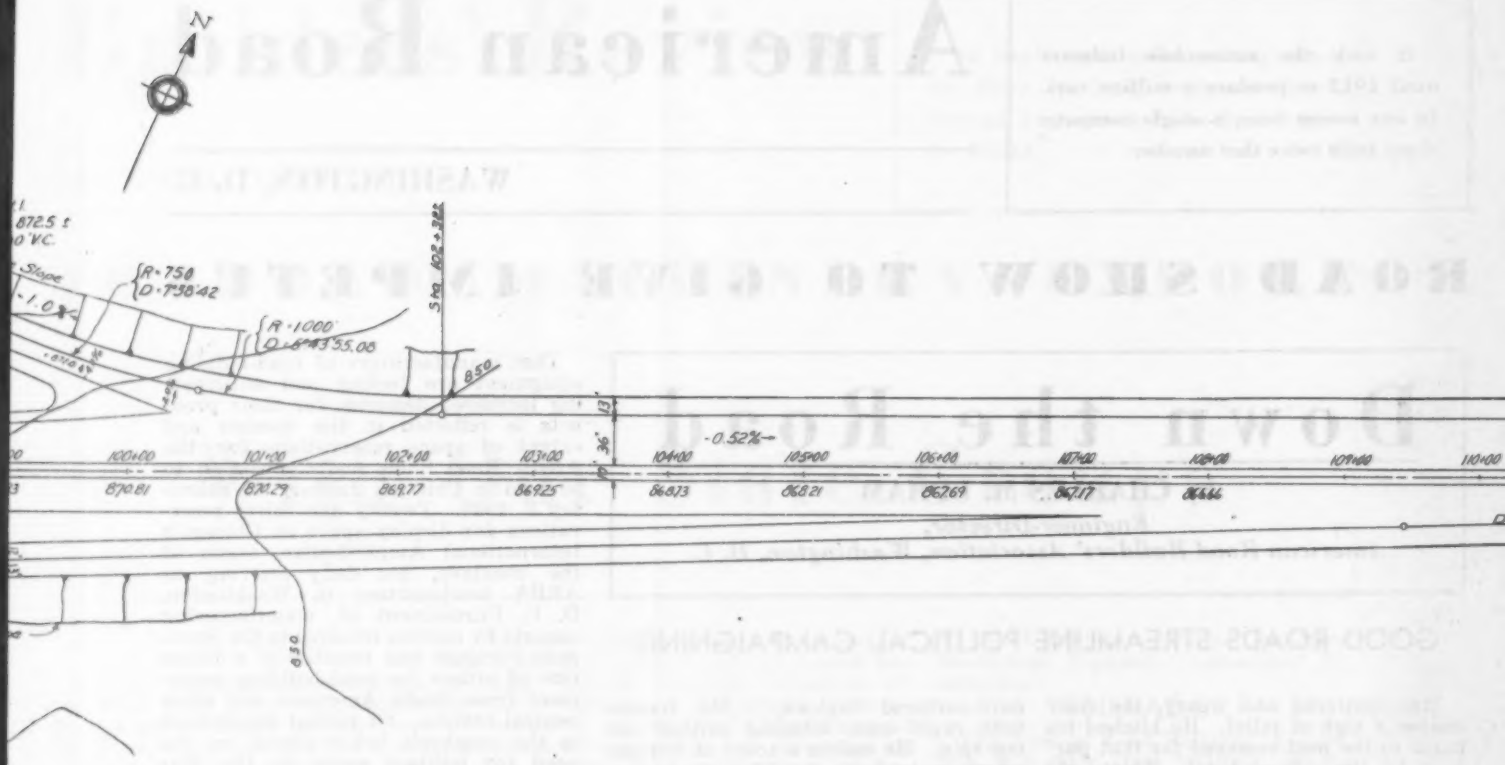
Datum 800
Sta 93+00


N
Top Curb
R=125'
El. 868±
Grade to uniform slope
Flat Slope
1½:1 Slope
Sta 95+45.0
164.00'
-12.4%
+2.4%
R=500'
D=11°28'42"
P.V.I.
El. 872.5 ±
300' V.C.
Toe Slope
-1.0%
R=750'
D=7°38'42"
R=1000'
D=5°43'55.08"
Sta 102+32±
Grade to uniform slope
El. 872±
High Curb
-1.2%
P.V.I. 873.93
400' V.C.
-0.52%
89+00
90+00
91+00
92+00
93+00
94+00
95+00
96+00
97+00
98+00
99+00
100+00
101+00
102+00
879.93
878.73
877.53
876.33
875.21
874.27
873.47
872.89
872.37
871.85
871.33
870.81
870.29
869.77
D=2°00'
P.V.I. 200' V.C.
El. 854.2
Sta. 28+15
Sta. 28+21.11 Approach
Sta. 94+00 Turnpike
El. 868±
Grade to uniform slope
-3.4%
P.V.I. 300'
El. 871.4
Daylighted Area
Toe Slope
Grade to uniform slope
+3.2%
R=400'
Radius = 400'
P.V.I. -300 V.C.
El. 859.0±
P.V.I. Sta. 24+40
El. 862.45 400 V.C.
861.00 on V.C.
861.39
861.63
R=1000'
D=5°43'55.08"
+0.5%
-0.5%
27'
℄ Toll Booth - Sta 21+00
P.V.I. Sta. 17+50
El. 859.0 400' V.C.
Original Ground
TURNPIKE IN
WITH ONE TOLL BO
THE TUR
℄ Turnpike
℄ Interchange Sta 98+00
Collector Approach
Farm Lane
L.R.45
14 Miles to Fort Lauder



TURNPIKE INTERCHANGE
WITH ONE TOLL BOOTH LOCATED OFF
THE TURNPIKE

Note:-
Drainage not shown

Insert from
ROADS and STREETS
October, 1939

10000
D=8°-30'

It took the automobile industry until 1912 to produce a million cars. In one recent year, a single company alone built twice that number.

American Road

WASHINGTON, D. C.

ROAD SHOW TO GIVE IMPETUS

Down the Road

by CHARLES M. UPHAM
Engineer-Director,
American Road Builders' Association, Washington, D. C.

GOOD ROADS STREAMLINE POLITICAL CAMPAIGNING

Mud-spattered and weary, the rider heaved a sigh of relief. He hitched his horse to the post reserved for that purpose by the village hotel. Thirty-odd miles he had travelled before noon that day, an accomplishment he reviewed with pride. He was justified to consider himself an able and tenacious horseman. His had been no tenderfoot trail.

He had started his journey on an early fall day in the glare of an Indiana sun that had dawned with merciless warmth. Shimmering heat waves rose from a wagon-rutted road of sand and rock and disappeared in a transient billow of dust. A grey, dry cloud enveloped man and mount. Then Autumn, playing a seasonal prank, stirred wind to life. Moisture-laden clouds scurried darkly overhead. Thunder crackled ominously. With drenching abruptness, the suddenly heavy sky released a minor deluge. The rain beat the road into a grasping welter of mud and the rider found the going even more difficult and unpleasant. Small wonder he sighed with relief when he reached his destination.

Who was he? An outlaw, perhaps, fleeing justice? A doctor answering an emergency call? No, the rider was a candidate for Indiana's governorship, making his campaign rounds. But that was forty years ago. Flip the pages of the calendar forward into 1939. Let's look at one of today's candidates.

A streamlined automobile and trailer, spotlessly white and gleaming, roll into an Indiana town and halt in the central square. A crowd gathers. The candidate appears at the door of his trailer. He waves a salute to his waiting audience. Aided by microphone and loudspeakers, the candidate delivers his message, outlines his platform, utters his promises with a giant's voice.

His speech completed, today's candidate greets a friend. "Hello, Tom! No, I wish I could stay for lunch. Just can't make it this time. Got two more towns on my list for today." Within a few moments, he is off again, speeding smoothly, effortlessly over a modern, hard-surfaced highway. He travels with rapid ease, minding neither sun nor rain. He makes a score of friends, where yesterday's candidate made one, and he does it in a fraction of the time.

Today's candidate could easily be any aspiring politician in any of the United States. In fact, he is Judge James A. Emmert of Shelby County's circuit court who is campaigning for the Indiana Republican gubernatorial nomination. One recent day, Judge Emmert packed clothes and bedding into his sleek but roomy trailer. Bidding his wife and three children farewell, he started on a two-month campaign tour. At its conclusion, he will have visited each of Indiana's ninety-two counties. Judge Emmert, in undertaking this extensive itinerary, does not have to be a rugged and adventurous traveller. Guided by a state road map, the judge will glide over roads that form a part of America's system of highways. This, of course, is the same system which transports thousands of Americans who make their homes on wheels.

While Judge Emmert is methodically visiting the towns and counties of Indiana, vehicles similar to his are passing under the palms of tropical Florida and wending through the majestic redwoods of Northern California and Oregon. These roamers of today suffer few of the hardships which their grandparents took as a matter of course during the horse-and-buggy era. Like his fellow trailerites, Judge Emmert carries his home with him. Retiring for the evening is a mere matter of parking his car and winding the alarm clock. In the daytime, during business hours, the trailer is automatically transformed into an efficient campaign headquarters.

The candidate of yesteryear, jogging slowly along on horseback, did not dream of the travel facilities which would be afforded his 1939 counterpart by the automobile and scientifically constructed roads. Yes, modern highways, adequately financed and properly engineered, rendered an ever-increasing service to America.

That manufacturers of road-building equipment are feeling and anticipating increased demands for their products is reflected in the number and extent of space reservations for the ARBA Road Show and Convention to be held in Chicago, January 29-February 2, 1940. Twenty and thirty reservations for display space at Chicago's International Amphitheatre, scene of the conclave, are daily arriving at ARBA headquarters in Washington, D. C. Curtailment of manufacturing exports by nations involved in the European struggle has resulted in a rising tide of orders for road-building equipment from South American and other neutral nations. Of special significance is the emphasis being placed on the need for military roads by the War Department. It has been officially noted that military roads will also help solve a peacetime traffic problem which is rapidly approaching the point of crisis.

New roads and new designs for old roads and concomitant construction questions have inspired manufacturers to answer with revolutionary models of road-building equipment. New road-building machinery and equipment has been or is now being "road-tested" and will be ready for display and inspection at the ARBA Road Show and Convention.

During the five-day meet, 40,000 and more delegates representing 48 states and 36 foreign nations, will throng Chicago's huge International Amphitheater. They will be addressed by officials in close touch with the city, county, state and national road setting. Included will be officials from the War Department, the PWA and the Department of Commerce. John M. Carmody, Federal Works Administrator, Senator Carl Hayden and Representative Wilburn Cartwright will report on road conditions and needs as viewed by their authoritative eyes.

The Convention may well mark the birth of a new era of road administration and construction. Subjects of paramount importance to administrators, planners and builders will occupy the comprehensive program of convention sessions. The recent report of the Public Road Administration on the need for a system of interregional super-highways has created a new horizon on the road-building skyline for highway contractors, state, county and municipal officials, engineers, manufacturers, distributors and planners. They will be represented in unprecedented numbers at the Convention. The achievements and aims of road builders from foreign nations will be presented for discussion in the Windy City.

Convention headquarters for the ARBA will be the Stevens Hotel.

Builders' Review

OCTOBER, 1939

All trucks and busses passing over the Huey P. Long bridge at New Orleans, La., must keep to the left on the bridge.

TO ROAD MACHINERY EXPORT

With Our State Groups

FLORIDA

Special transportation facilities to the 1940 Road Show and Convention have been arranged for members of the Florida Section, ARBA, according to M. M. Frost, chairman of the section's "On-to-Chicago" Committee. Members will leave Tampa in a special pullman car on January 27. Two additional cars will join the Tampa delegation at Jacksonville that afternoon. En route to Chicago, delegates will be provided with recreational facilities. A large block of single and double rooms have been reserved for the group at Chicago's Sherman hotel.

GEORGIA

Charles M. Upham, engineer-director of the American Road Builders' Association, and Murray D. Van Wagoner, ARBA president and Michigan state highway commissioner, were guests of honor and speakers at the second annual Georgia Highway Jamboree at Lithia Springs, September 21. Representatives of other ARBA affiliates at the Jamboree, which was sponsored by the Georgia Highway Contractors' Association, included Floyd E. Koontz, secretary, Michigan Road Builders' Association, and G. Donald Kennedy, deputy highway commissioner of Michigan; Herbert R. Anderson, president, and Taylor G. Soper, executive secretary, Illinois Road Builders' Association; A. E. O'Brien, secretary, Associated Pennsylvania Constructors; Francis J. Kelly, secretary, District of Columbia Section, ARBA; George R. Dempster, engineer-manager, Tennessee Road Builders' Association; A. G. Underwood, secretary, Alabama Road Builders' Association; H. M. Birtley, secretary, Florida Section, ARBA, and R. N. Kinnaird, executive secretary, Mississippi Highway Contractors' Association.

NEVADA

The Nevada Road Builders' Association is a new state affiliate of the American Road Builders' Association. Robert A. Allen, state highway engineer, was elected president of the group at the September 14 organization meeting in Reno. Bernard C. Hartung, director, state highway department traffic and safety division, will serve as secretary-treasurer. Other officers include William H. Smith, vice-president; H. H. Swinburne and M. D. Anderson, directors for one year; C. V. Melarkey and Arthur Revert, directors for two years and A. E. Holgate and Leon Mack, directors for three years. William C. Slee, ARBA engineer-director, was the principal speaker at the organization meeting.

127 PUBLICATIONS CARRY ROAD SHOW ADVERTISING

The Public Relations Department of the ARBA has issued advertising plates to 127 publications for promotion of the 1940 Road Show-Convention, one of which appears elsewhere in this magazine. This is the first in a series of three advertisements publicizing the conclave which has kept midnight oil burning in the offices of the ARBA Public Relations Department. The next advertisement to be issued will stress "Destruction Over There—Construction Over Here!" Designed to appeal to administrator, planner and builder alike, reactions at this date strongly indicate that these advertisements will be a definite influence in promoting the Road Show-Convention.

300 RADIO STATIONS TO BROADCAST ARBA SERIES

One of the greatest single radio campaigns in history has been inaugurated by the Public Relations Division of the ARBA. Over 300 American radio stations are co-operating with the ARBA in an effort to save lives on American roads. A series of three transcriptions has been prepared by the Public Relations Division of the ARBA dramatizing the theme of "Safe Highways." The greatest majority of safety campaigns via press and radio have stressed education of the motorist. The ARBA series focuses the light of public opinion on the unsafe structural condition of a large percentage of highways in the United States.

Realizing that the public listens with more attentiveness to "names" when related with authority, the ARBA public relations division has secured the co-operation of government officials in the presentation of its 1939 series. Murray D. Van Wagoner, president of the American Road Builders' Association and Michigan state highway commissioner, and Charles M. Upham, engineer-director of the ARBA, will also take part in these broadcasts. To further attract, hold and convince listeners, the words of these speakers have been combined with the dramatization of the unsafe conditions the motorist encounters on highways that warn him to beware of these structural defects.

VAN WAGONER TO PRESIDE AT TRAFFIC ENGINEERS' INSTITUTE

ARBA President and Michigan State Highway Commissioner Murray D. Van Wagoner will preside at the first general session of the tenth annual convention of the Institute of Traffic Engineers in Atlantic City, N. J., October 14-17. This session will deal with the three major phases of the highway traffic problem—surveying, planning and financing. Leslie J. Sorenson, president of the institute and city traffic engineer, Chicago, Ill., will preside at a joint session with the National Safety Council Street and Traffic Section. Presiding officers at other sessions will include Maxwell N. Halsey, assistant director, Yale University Bureau for Street Traffic Research, New Haven, Conn., and Harold F. Hammond, secretary-treasurer of the institute and director, National Conservation Bureau Traffic Division, New York City. Convention headquarters will be at the Ritz-Carlton hotel.

(*Continued from page* 48)

The structure with a 30 deg. skew is worthy of special discussion due to the fact that it was contended by some interested that the skew was too severe, in light of the narrow roadway width (20 ft.), to give suitable construction. It was maintained by these people that unless a line drawn normal to one abutment at the obtuse corner would fall either within or a very short distance without the other abutment, the structure was unstable. An extensive search was made for structures already constructed which do not fulfill this criterion. The search failed to reveal one. However, the structure had been carefully analyzed by accepted methods and it was decided to complete the construction of at least one of these frames. This having been done, the structure was subjected to test loads consisting first, of two parallel trains of trucks of approximately 13 tons each rolling across the structure spaced approximately 24 ft. center to center so that 6 trucks were on the structure at one time; and second, of a 40-ton shovel rolled across the span. Observations made at the time centering was struck, when the backfill was placed, and during the test live loading showed deflections well within those computed during the design. In fact, the deflections of the structure during test live loading were so small that it was impossible to measure them by means of an engineer's level. Rotations at the supports could be observed but were of such magnitude as to be represented by the difference in ease with which a knife blade could be inserted in the joint between the deck and wing walls prior to and during the loading. The results obtained were such as to indicate that rigid frame structures built on this skew and with this proportion of roadway width to span are perfectly sound if designed in accordance with accepted methods of analysis. The results obtained from these tests eliminated the objections of those who contended the structure to be unsound and made possible the release for construction of the remaining structures of this type.

In no case have any rigid frames been built on this project except on foundations of unyielding character. Where foundations were not of this character or where skews in excess of 30 degs. were encountered, one of two other types of structures was selected. Approximately one-half of the remaining overhead structures are of reinforced concrete T-beam type consisting of two spans necessitating use of a pier in the medial strip. The range of skews on this type structure is from 0 deg. to 45 degs. Architectural treatment has been given in order to secure pleasing appearance in these structures.

The remaining overhead structures are of plate girder design of single span for skews up to 45 degs. and the remainder two spans, except one crossing on a skew of 69 degs. 15 min. which required a three-span structure and very special treatment. This structure has piers in the medial strip and at the edge of shoulder and is designed with square-off spans, resulting in a total length of 315 ft.

A few of the structures carrying the turnpike over intersecting roads are in fills of such height that ordinary T-beam or I-beam construction would result in abutments too high to be either economical or practical. In these cases, arches under the fills have been utilized. The most notable one of this type of grade separation is that carrying the turnpike over State Highway Route 26 near Everett in Bedford County. This structure has in excess of 40 ft. of fill over the crown resulting in a length of barrel of more than 200 ft.

The continuous girder, 480 ft. long, over Dunnings Creek was designed by Parsons, Klapp, Brinckerhoff & Douglas, Engineers, New York City; that over the Raystown Branch of the Juniata River near Bedford, a continuous girder 590 ft. long, by Modjeski & Masters, Engineers, Harrisburg, Penn. All other structures in the project were designed by the engineering staff of the Pennsylvania Turnpike Commission.

Live Loading Used.—The highway live load on the roadway portion of bridges carrying the turnpike consists of a single 20-ton truck with semi-trailer preceded and followed by continuous trains of 20-ton trucks. The load on the front axle of each truck was taken as 4 tons and that on the rear axle as 16 tons. The load on the axle of the semi-trailer was taken as 12 tons. The distance between axles of the individual trucks and between the rear axle of the truck and the axle of the semi-trailer was taken as 14 ft. The distance between the rear axle of any truck, or of the semi-trailer, and the front axle of the following truck, was adopted in each case to be 30 ft. The lateral distance used between wheels on the same axle, was 6 ft.

Impact.—All calculated live load stresses, except those due to sidewalk loads and centrifugal, tractive, and wind forces were increased by allowance for impact as follows:

For stringers and interior floor beams, 25 per cent with concrete floors.

For stringer connections, end floor beams, floor beam hangers, and connections, 60 per cent.

For all other portions of structure,

$$I = \frac{75}{L + 200}$$

Where I = the impact coefficient;

L = the loaded length of span in feet producing the maximum stress in the member considered.

Railings.—Substantial railing are provided along each side of all bridges. The top of the railing is 3 ft. above the finished surface of the roadway adjacent to the curb or, if on a sidewalk, not less than 3 ft. 6 in. above the sidewalk floor.

Each railing was designed to resist a force of not less than 500 lb. per lin. ft., applied horizontally on a line 20 in. above the roadway surface, one of not less than 150 lb. per lin ft. applied horizontally at the top of the railing, or one of 100 lb. per lin. ft. applied vertically, whichever gave the greatest stress.

Because of the limited time allowed for the design and construction of the turnpike, unusual speed was required in the design and preparation of drawings for the structures. It was necessary to prepare a complete set of standards for the work since none was available for structures of the roadway width required. A complete bridge organization had to be built up to handle this work. The men worked exceptionally long hours over a period of more than six months under pressure in order to accomplish this work.

Prior to the first of the year, 1939, the designs and drawings for only 46 structures had been completed. Designs and drawings were completed for the remaining 256 structures so that they could be advertised prior to the 18th of August. This means that these structures were completed at an average rate of approximately 8 per week and in some weeks bids were received on contracts involving as many as 35 structures. Most of these structures were of a special nature requiring considerable individual study and special design. During the entire design period of this work, at no time was it necessary to delay the advertising for bids because designs for the structures were not completed.

A very fast schedule had been adopted for the advertising for bids and the bridge division so organized and conducted its work that it was never necessary to revise the schedule to permit additional time for the completion of bridge drawings. The designers were continually impressed with the principle that speed must be accomplished by additional effort without sacrifice of careful design and attention to detail.

Materials

For the sake of uniformity, concrete specifications are the same for all grading and drainage, and paving contracts. Aggregates in three nominal sizes are specified: sand (passing 4-mesh standard sieve), 1-in. aggregate (4-mesh to 1-in.), and 2-in. aggregate (1-in. to 2-in.). Provision is made for varying the proportions of these materials within reasonable limits to obtain maximum workability of concrete. Aggregate grading requirements are as follows:

Fig. 11—Twin Arch Over Brush Creek. Each Span Is 52 ft.

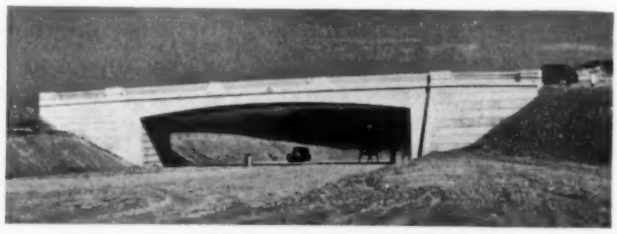


Fig. 12—Typical Rigid Frame Grade Separation Structure.

PERCENT PASSING SQUARE SIEVES

Sieve Size	Sand	2B Aggregate	3A Aggregate
2½–mesh	....	....	100
2	....	....	90–100
1½	....	100	35–70
1	....	85–100	0–15
½	....	25–60	....
4–mesh	95–100	0–10	....
16	45–80	....	....
50	10–30	....	....
100	0–8	....	....

Normal portland cement having a specific surface of not less than 1,600 square centimeters per gram (Wagner turbidimeter) and passing the autoclave soundness test is required.

Concrete mixes are of three general types. Class B concrete is used for heavy sections, generally containing only a small amount of reinforcing, such as footings and heavy abutments. Class A concrete is used in thin and heavily reinforced concrete sections subject to heavy load or impact. The third type of concrete is used exclusively for pavement. Maximum water-cement ratios are 7 gal. per bag of cement (0.62 by weight), 6 gal. per bag (0.53 by weight), and 5½ gal. per bag (0.49 by weight), respectively, for the three types of mixes. Approximate cement content for three classes of concrete are as follows:

Class of Concrete	Cement Content Bbls. per Cu. Yd.
B (2-in. agg.)	1.27
(1-in. agg.)	1.39
A (2-in. agg.)	1.49
(1-in. agg.)	1.61
Paving (2-in. agg.)	1.56
(1-in. agg.)	1.72

Concrete for tunnels will contain sand of the same grading as that specified for the highway contracts and coarse aggregates in two sizes, 4-mesh to ¾-in. and ¾-in. to 1½-in., the smaller sizes of coarse aggregate being desirable because of tunnel concrete placing methods. Control will be on a basis of water-cement with an approximate minimum cement content of 1.6 bbls. per cu. yd.

Field control of water-cement ratio of concrete is maintained by making routine moisture determinations on all aggregates, measuring the batched mixing water, and determining therefrom the water ratio. Water ratios thus determined are correlated with slump measurements forming a workable basis for control of consistency and water-cement ratio. Aggregates are batched by weight, corrections being made for contained moisture. Cement is batched either by weight or by full bags. Water is usually batched by volumetric batcher.

Consistency of concrete is governed by the criterion that the least quantity of mixing water consistent with proper workability of concrete in the forms shall be used. Internal vibration is specified for concrete in structures permitting efficient placements with slumps of from 1 to 3 in.

Record tests include compression strengths of 6 x 12 in. laboratory cured test cylinders to indicate quality of concrete placed in the structures and transverse beam tests on specimens cured with the structure to indicate quality of concrete therein as cured in the field. Results of the beam tests serve as guides in determining time for removal of form centering and the loading of structures.

Strength requirements for form stripping vary with the type of structure. In general, removal of form centering for arches and similar structures is permitted after twice the time interval required for test beams to attain a strength of 500 lb. per sq. in. as indicated by modules of rupture test.

Typical average compressive strength for the 3 types of mixes noted are shown below. Specimens are cured for 3 days at the site of the work and for the remainder of the time in a 70 deg. moist room.

	Compressive Strengths, lb. sq. in. 7 Day	28 Day
B Mix	2,400	3,200
A Mix	2,700	3,700
Paving Mix	3,400	....

The average 7 day modulus of rupture determined on 6 by 8 in. beams of paving mix concrete (August 17 to September 5) cured with the paving slab has been 840 lb. per sq. in.

Paving Operations.—At this writing only one paving contract is actually in operation though others are ready to start in the immediate future. The fact that only one paving operation has been in progress has furnished an opportunity for close observation of all phases of the work and has made it possible to train inspectors for the large amount of paving to follow.

Particular attention is directed toward mix-proportioning and water-cement ratio for consistency of concrete in order to minimize segregation, reduce excess surface mortar and control uniformity of operations in general.

In the present operation one 34E dual drum mixer, one screw spreader, one two-screed transverse finisher, and one longitudinal finisher make up the essential items of power equipment. Due to the stiff consistency of the mix, the contractor now laying slab has found the mechanical screw spreader to be particularly advantageous. Reinforcing steel is placed, as will be noted by referring to the typical cross-section, Figure 1, a depth of 2 in. below the top of the slab. Expansion joints are vibrated and side forms are spaded. The longitudinal finisher is followed immediately by straightedges which normally have very little work to do. A burlap drag follows the straight-edging.

With closely controlled consistency the coarse aggregate is well distributed and only a thin layer of surface mortar results.

Saturated curing mats are placed as soon as the surface has stiffened sufficiently to receive them and thorough wet curing is maintained for the specified 3-day period.

The big problem of materials supply will come next spring when paving operations get into full swing. The commission is cognizant of this fact and is preparing plans now that will insure a constant source of supply in the required quantities. At the present time there are 26 primary paving contracts scheduled to complete the job.

Interchanges

It is expected that the turnpike will be used for long distance traffic primarily and that it will accommodate a significant amount of traffic from outside the state. Anticipating this use, a review was made of the traffic flow maps of Pennsylvania, Ohio, West Virginia, Maryland and the U. S. Bureau of Public Roads, to develop the main traffic flows into and through Pennsylvania. The routes handling this traffic at present were also investigated to determine the volume that may be diverted to the turnpike, as well as the points of entrance and exit which would be most convenient for this diversion.

In general, the location and spacing of the interchanges has been governed by natural barriers. The mountain ranges, extending north and south from the turnpike, have delimited that part of the state which the turnpike traverses, into natural traffic sheds. Each of these valleys is served by a main highway and the interchange has been located generally at the site where the turnpike crosses this feeder route.

The experience of other toll facilities have demonstrated, that in weighing alternate routes, motorists consider them in their entirety from origin to destination. The inherent advantages of the turnpike will be of no avail unless the proper approach highways are available to accommodate traffic in its direction of travel. Consequently, the approach roads have been investigated for each interchange and, wherever possible, the interchange has been located on a U. S. numbered route. These highways are generally kept well maintained and since they are also shown on the traffic maps of all the gasoline companies, traffic will have less difficulty in locating the interchanges.

A tenable income figure was difficult to obtain because of the number of combinations involved in analyzing traffic from each source through an interchange to all the points of destination on and beyond the turnpike.

The estimates of potential traffic for the interchanges are based on origin and destination data which were collected by the Highway Planning Division of the Pennsylvania Department of Highways from May 2 to May 9, 1937. Field parties were placed at sixteen stations throughout the state and located so as to interview most of the through traffic that passed within the region of influence of the turnpike. This potential traffic was then grouped according to the section of the turnpike that it would use between the indicated points of origin and destination, and the totals of each group were expanded to an average annual volume in accordance with the counts that had been previously taken by the highway department on the various routes. Following this, the factors for the annual increase in traffic and for induced traffic were applied to obtain the estimated potential traffic for the average day in 1941.

Irwin Interchange.—The Irwin interchange is the western terminus of the turnpike. It is located on the newly relocated Lincoln Highway, U. S. Route 30, approximately 20 mi. east of Pittsburgh.

New Stanton Interchange.—This interchange has been developed at the intersection with U. S. 119. It is 8.6 mi. east of Irwin and 34.6 mi. west of the Somerset interchange.

Somerset Interchange.—The area to be served by this interchange, where U. S. 219 intersects, is relatively broad. The New Stanton interchange is 34.6 mi. to the west, while the Bedford interchange is 36.0 mi. to the east.

Bedford Interchange.—The Bedford interchange will serve the area between the Allegheny and Clear Ridge Mountains, and is located on U. S. 220, at a site approximately 2.5 mi. north of Bedford. On the turnpike, this interchange is 36.0 mi. east of Somerset and 17.1 mi. west of Breezewood.

Breezewood Interchange.—Breezewood is the only intermediary interchange at which the turnpike connects directly with the Lincoln Highway. The territory is rather sparsely settled and is not expected that much traffic will originate from the vicinity around the turnpike. It is 17.1 mi. east of Bedford and 16.6 mi. west of Fort Littleton.

Fort Littleton Interchange.—The Fort Littleton interchange is situated in the valley between Tuscarora and Sideling Hill Mountains on U. S. 522, a distance of 8½ miles north of McConnellsburg. On the turnpike, it is 16.6 mi. east of Breezewood and 9.1 mi. west of Willow Hill.

Willow Hill Interchange.—The Willow Hill Interchange is being provided to serve Path Valley, between Tuscarora and Kittatinny Mountains, and is located on Pennsylvania Route 75, approximately 14 mi. north of Fort Loudon. On the turnpike, this site is 9.1 mi. east of Fort Littleton and 12.9 mi. west of Blue Mountain.

Blue Mountain Interchange.—The Blue Mountain interchange connects with Pennsylvania route 944 near the Franklin-Cumberland County line, approximately 2 mi. east of the Blue Mountain tunnel. The site is located immediately adjacent to the first mountain barriers on the turnpike when traveling westward.

Carlisle Interchange.—This facility is being provided to accommodate the traffic from the north in the Susquehanna River Valley that may wish to by-pass Harrisburg. It has been developed so that the toll station for Middlesex, the eastern terminus of the turnpike, is also located at this point. Provisions are being included, however, whereby it will be possible to collect the additional fare to Middlesex.

Middlesex Interchange.—The Middlesex interchange is the eastern terminus of the turnpike situated on U. S. 11, a distance of approximately 16 mi. west of Harrisburg. It is being designed so that the turn-

pike may be continued eastward towards Philadelphia at some future date with a minimum of alteration and reconstruction.

Notes on Interchange Design

The ten interchanges, or points of connection with the existing state highways at which traffic will enter and leave the turnpike, consist of accelerating and decelerating lanes leading to four ramps, one off-bound and one on-bound for each direction on the turnpike, which are converged to a single connection with the state highway.

A fundamental principle in designing an interchange is that traffic must get on and off the turnpike without turbulence or accident. In order to reduce costs of operations at the various interchanges it was decided to keep personnel operation costs to a minimum by having only one toll booth for each interchange. It will take care of both the incoming and the outgoing traffic. The interest on an investment providing a $25,000 bridge is less than $1,200 per year, while the cost of personnel alone for operating another toll booth with three 8-hr. shifts per day at each interchange would be considerably higher. Provision for only one toll both necessitated the building of a structure that would avoid making any left turns on the turnpike. All interchanges are so located that approaching traffic can look down on them and readily picture the layout. By locating them in low terrain with approaching grades on higher levels for the turnpike, a complete picture of the layout can be had which will aid the driver of a vehicle on the turnpike to adjust himself to its location. This allows time for slowing down if leaving the turnpike and gives the driver a sight distance on the entering vehicles that are about to turn into turnpike traffic.

Decelerating Lanes for Leaving the Turnpike.—Deceleration lanes are 1,200 ft. in length, set parallel to and contiguous with the turnpike paving as shown in Figure 13. These lanes will give allowable time for slowing down traffic from high speed. Engine deceleration alone will be sufficient in slowing down before leaving the turnpike proper. The driver in turning a vehicle to leave is given ample curvature for making the first turn on a radius of 1,000 ft. and then follows around a series of gradual decreasing radii on compounded curves which corresponds closely to a true spiral, the reduction in radii being from 1,000 ft. in length to approximately 100 ft. minimum length of radius. The rate of deceleration upon the basis of the design is figured at 6.44 ft. per sec. per sec. from point of curvature of turnout lanes. The length and radii of the turnout lanes were established on the basis of a longitudinal braking factor of 0.2 and a lateral friction factor of 0.2 due to centrifugal force. This will enable a car to leave the turnpike at 56 m.p.h. and slow to 20 m.p.h. on reaching the 100 ft. radius curve.

Traveling at a high rate of speed over a period of time has the psychological effect on the driver of causing him to feel that he is going quite slow when his speed is reduced 10 or 15 mi. per hr. He has difficulty in adjusting himself to a low speed. Therefore, the designs are based upon the reaction time and ability of the average driver to decelerate at a comfortable speed which at all times will enable him to keep the vehicle under

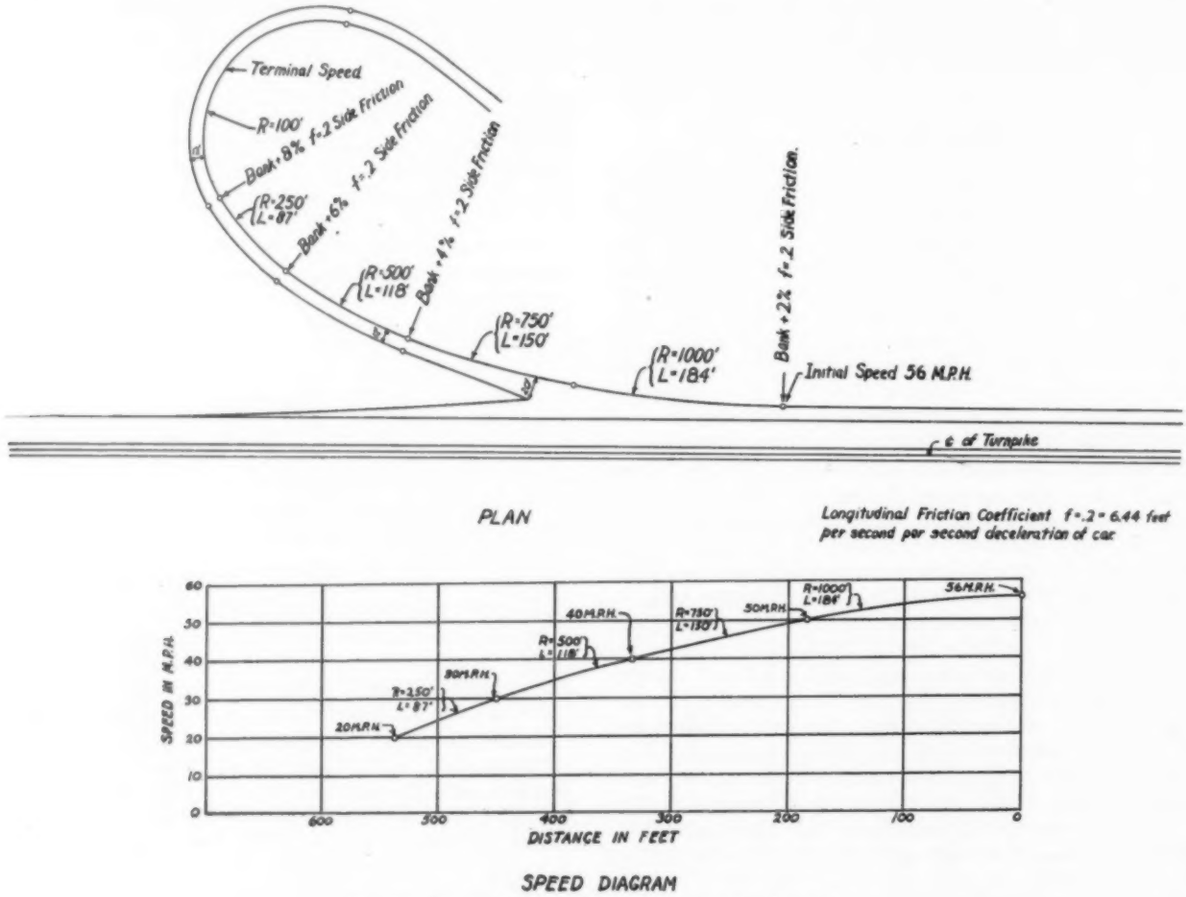


Fig. 13—Speed Study of Turnouts on Interchanges.

control. Any driver exceeding these speeds will naturally find a decidedly uncomfortable steering development which will warn him to slow down. Sufficient time and distance is provided so that he may do so in safety.

Acceleration Lanes for Entering the Turnpike.—Entrance accelerating lanes are provided similar to the decelerating lanes. Their purpose is to provide sufficient distance for cars to accelerate to the prevailing speed on the turnpike before encroaching on the normal flow of traffic. To enter the main flow of turnpike traffic immediately would create turbulence or accidents. The 1,200 ft. accelerating lanes were provided in order that the entering vehicle would be in full view of drivers on the turnpike for a period of several seconds and to give each driver a chance to make an adjustment in speed so that his motion would coincide with that of the other vehicles.

At the toll booths no grade in excess of 2 per cent is employed. Tests showed that this grade would allow cars to stand still without much tendency of rolling back while the vehicle was in neutral without set brakes. Such a case might occur during the paying of toll. Enough tangent distance is provided at either side of the toll booth that trucks and trailers can straighten out before crossing the recording treadles. This eliminates the possibility of double registration on the treadle counters near the toll booths.

Curbs and roughened pavement is used at strategic points to aid in keeping cars in their proper lanes. Many studies were made of the layouts for each interchange to get the best design combined with the most economic aspects and to fit the local topographic conditions.

Following is a table showing the total length of paved roadway at the various interchanges:

APPROXIMATE TOTAL LENGTH OF PAVED ROADWAYS AT INTERCHANGES, FT.
(Including Acceleration and Deceleration Lanes)

Location		
Irwin	9,000	Twenty miles east of Pittsburgh on U. S. 30, Lincoln Highway.
New Stanton	8,700	Village of New Stanton.
Somerset	9,400	Boro of Somerset.
Bedford	8,400	North of Bedford.
Breezewood	8,500	On U. S. 30, Lincoln Highway, east of Everett.
Fort Littleton	7,900	Fulton County between Sideling Hill and Tuscarora Tunnels.
Willow Hill	9,900	Between Tuscarora and Kittatinny Tunnels in Path Valley.
Blue Mountain	9,300	Just east of Blue Mountain Tunnel, north of Roxbury.
Carlisle	5,400	Town of Carlisle.
Middlesex	4,100	Eastern terminus of Turnpike, 16 miles west of Harrisburg.

TUNNEL DESIGN

Including Portals, Ventilation, Lighting and Operation

ABOUT 50 years ago portions of the tunnels were driven. Thus there was offered unusual opportunity for detailed study of underground conditions seldom available on proposed tunnel projects. Geological studies included core borings to verify the character and attitude of the rock in the undriven areas.

The cross section for the tunnel is such as to require enlarging the driven portions of the old tunnels. Fifty years of weathering had caused considerable deterioration in the weaker rock of the tunnels, resulting in many falls. Some of these falls were of such proportions as to almost close the tunnel opening and to form a dam, which in one instance impounded a subterranean lake from seepage water, approximately 18 ft. in depth. In the interest of economy, it was decided to utilize most of the old tunnels. Old Negro Mountain tunnel and Old Quemahoning Mountain tunnel were converted into deep cuts.

Accurate surveys were made, and plans, profiles, and cross sections were plotted. The best use of the old tunnels was determined by the study of various alignments and grades using templates of the excavation lines for the new tunnel section which were superimposed upon the plotted cross sections of the old tunnels and the proposed new line shifted about to get maximum benefit from the old bores. Figure 1 shows the cross section relationship between a single track section of the old tunnels and the turnpike section. The double track portion of the old work conforms closely to the designed cross section of the turnpike. Figure 2 is interesting in that it shows the plan and profile of Kittatinny and Blue Mountains tunnels and the driven and undriven portions as abandoned by the old South Penn Railroad. As finally determined, only six of the nine original tunnels are to be completed and one new tunnel is to be constructed, totaling a length of approximately 6.7 miles of tunnels. In

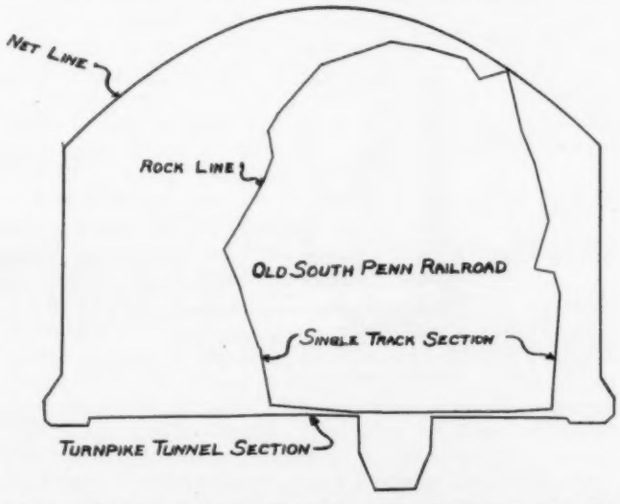


Fig. 1—Showing Relationship in Cross-section Between Typical Abandoned Single Track Tunnel Work and the Turnpike Section.

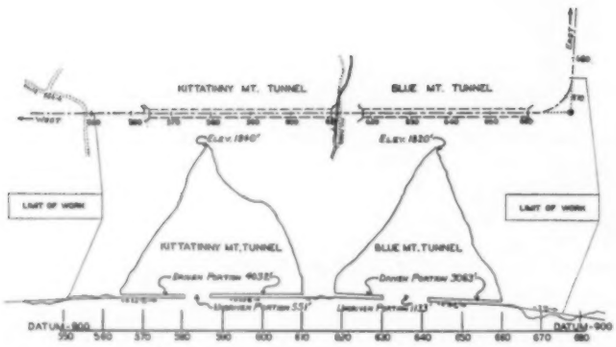


Fig. 2—Showing Abandoned Driven and Underdriven Portions of Blue and Kittatinny Mountains and the Line of the Turnpike.

this length, approximately 3.2 miles were previously driven, saving approximately one-third of the excavation which would have been required for entirely new tunnels, or a saving in money of approximately $2,000,000. This figure represents a tunnel saving, alone, for previous work done at present unit prices.

Table I gives the approximate lengths of the various portions of the tunnels at the beginning of construction.

The tunnel cross section provides for a two-lane highway 23 ft. wide between the curbs, with a sidewalk 2 ft. 10 in. wide on one side. The width between the inside

TABLE I—APPROXIMATE LENGTHS OF TUNNEL WORK

Tunnel	Total Length Feet	Driven Portion Rock Tunnel Feet	Undriven Portion Rock Tunnel Feet	Open Cut Tunnel Feet
Sideling Hill	6,792	3,237	3,379	176
Laurel Hill	4,574	810	3,552	212
Kittatinny Mountain ...	4,737	4,013	551	173
Blue Mountain	4,373	2,998	1,174	201
Allegheny Mountain ...	6,080	0	5,902	178
Tuscarora Mountain ...	5,336	3,710	1,452	174
Rays Hill	3,517	2,392	1,001	124
TOTAL	35,409	17,160	17,011	1,238

of the walls is 28 ft. 6 in. and the overhead clearance above the roadway will be a minimum of 14 ft. 4 in. The air duct for the forced ventilation is located above the roadway and occupies the space between the arched roof and the roadway ceiling. The sidewalls and the roof arch are to be constructed to a minimum thickness of 18 in. and the ceiling slab 5 in. The roadway is a reinforced concrete pavement 10 in. thick. A longitudinal drainage gallery extends through the length of each tunnel under the roadway and is fed by lateral and longitudinal French drains which collect the seepage from the rock and the drainage from the roadway.

The tunnel walls and roof will generally be placed against rock, as indicated by Fig. 3, but where the rock

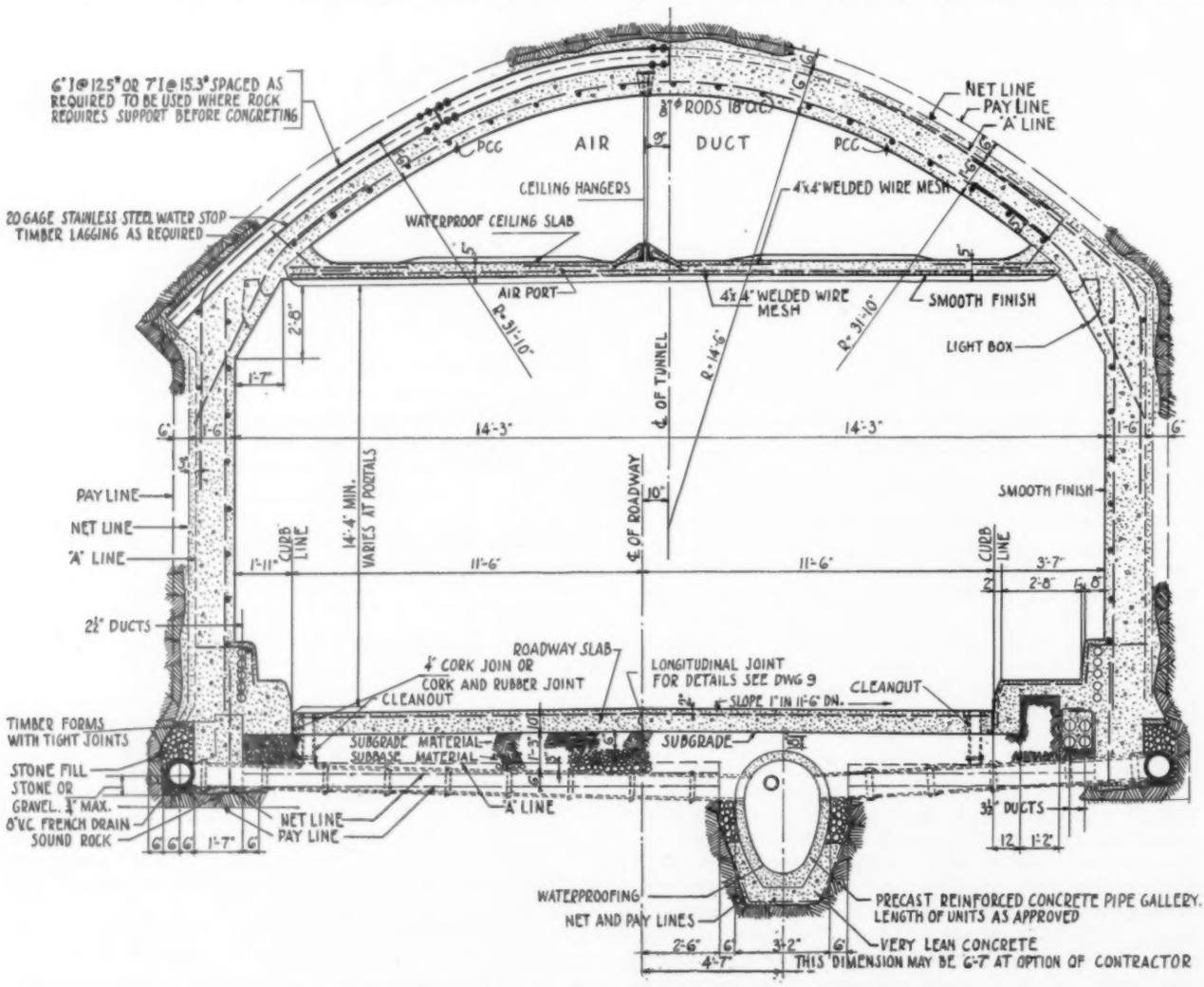


Fig. 3—Typical Cross-section Design of Tunnels for the Turnpike.

requires support the plans provide for the use of steel arch ribs. The spacing of arch ribs, and their size and weight, are left to the judgment of the field engineers, who will be guided by the character and attitude of the rock strata encountered. Where overbreakage is large or where the old tunnel opening extends outside of the new structure, the open space will generally be packed with stone or concrete. Where space is to be filled outside of the sidewalls, the plans provide for vertical beams to be placed in the sidewalls and for horizontal timber lagging to be supported by these beams. The space between the lagging and the rock will then be packed with stone before the wall concrete is placed. Where open spaces occur above the roof arch, the steel arch ribs will support timber lagging. Where high roof falls have occurred, special treatment will be required depending on the nature of the rock and the probability of more rock falling. It is planned that some openings will be shored with protected timber or steel and concrete supports. The plans also provide that in some cases, weak rock in these high falls will be permanently held in place by the construction of concrete diaphragm walls extending from the tunnel roof to the rock above. In the latter case, the rock ceiling will be protected from further disintegration by a covering of reinforced gunite.

Special features of the tunnel design are provided to take care of unusual conditions. Heavy timber sets will be used where ground conditions are so unfavorable that it will be impractical to use steel roof supports, and steel plate lining will be used in unusually wet sections. The borings have indicated that acid water will be encountered at some locations and the design provides for drains to be constructed of split vitrified clay pipe which will be anchored to the rock, so as to collect the acid water directly from the rock seams and convey it to the drains. These drains will be sealed with acid resisting cement before the concrete tunnel lining is placed against the rock.

One unusual feature deserves special mention, in that it is typical of the many new problems which confront tunnel designers. In Kittatinny Mountain the horizontal borings disclosed that a seam of very fine saturated sand approximately 10 ft. in width and under a hydrostatic pressure of approximately 200 lb. per sq. in. will be encountered in the excavation and construction of the tunnel. The contractor was required to bid a lump sum for the construction of this portion of the tunnel and to adopt his own methods for penetrating and constructing the tunnel at this location. The design of the special section of tunnel for this location prepared by the commission engineers consists of a heavy reinforced circular concrete structure.

Tables II and III require no explanation. They are recorded merely as matters of interest.

TABLE II

Tunnel Portals	Sea Level Elevations at Portals
West Laurel	2,224.57
East Laurel	2,483.96
West Allegheny	2,321.08
East Allegheny	2,298.67
West Rays	1,436.23
East Rays	1,427.60
West Sideling	1,286.07
East Sideling	1,263.85
West Tuscarora	996.77
East Tuscarora	999.53
West Kittatinny	1,061.00
East Kittatinny	1,064.70
West Blue	1,062.70
East Blue	1,026.40

TABLE III

Tunnel	Elev. Top Mt.	Elev. of Tunnel at Center	Height of Mt. Over Tunnel
Blue Mountain	1,770	1,042.0	730.0 ft.
Kittatinny Mt.	1,775	1,068.0	707.0 ft.
Tuscarora	1,900	1,000.0	900.0 ft.
Sideling	1,918	1,277.5	640.5 ft.
Rays	1,978	1,427.5	550.5 ft.
Allegheny	2,730	2,314.34	416.0 ft.
Laurel	2,800	2,456.0	344.0 ft.

Note: Elevations and distances are approximate. Elevations are above sea level at Sandy Hook, N. J.

Features Relative to Tunnel Design

The tunnel design was developed to meet the average conditions which it was known would be encountered. Where special conditions such as cave-ins, faults, wet areas, slip planes, and sand seams occurred it was necessary to treat each individually.

The problem of drainage is not alone one of simply disposing of accumulating underground waters. In addition, accurate information must be obtained regarding the character of the water. The waters may have deleterious effects upon the concrete lining of the vehicular tunnels. A detailed and continuing water analysis study was instituted along with the geological studies. They included chemical analysis where desirable. The pH value found is an indication of the relative acidity and alkalinity of the particular sample of water under consideration, and is measured as follows:

A pH value of 7.0 indicates neutrality
A pH value of less than 7.0 indicates acidity
A pH value of more than 7.0 indicates alkalinity

The relative activity indicated by the pH value may be shown by the following:

pH Value	Relative Acidity	pH Value	Relative Alkalinity
3.0	10,000	7.0	0
4.0	1,000	8.0	10
5.0	100	9.0	100
6.0	10	10.0	1,000
7.0	0	11.0	10,000

It is therefore evident that a low pH value is a distinct warning that the source of the sample of this low value must be given particular attention and provisions made to control this water into proper drainage channels.

Different and special designs were necessary to meet these water conditions, which incorporated the use of contraction joint water stops, sidewall vertical drains filled with aggregate, drainage gallery laterals, and chemically resistant waterproofing materials.

Water supply for sanitary purposes, for roadway and drainage gallery flushing purposes, and for the disposal of waste and sanitary waters were studied along with the problems of drainage in design.

Potable water for sanitary uses will be provided by wells drilled at each tunnel portal ventilation building. Any surplus water from these sources will be diverted to a sump for roadway flushing purposes.

The final disposal of drainage gallery water will be into a main drainage line starting at the portals and discharging at suitable low points beyond the open cut sections of the tunnel portals.

Ventilation.—Tunnel air requirements are based on the extensive investigations conducted by the United States Bureau of Mines in 1920, along with similar tests at the Holland tunnel, and the experience gained from later vehicular tunnels. The turnpike tunnels may not expect the traffic density that other existing vehicular tunnels experience, especially in metropolitan areas. However, the maximum capacity of the ventilation system is designed not only to take care of maximum traffic density, but also to take care of any possible emergency

which, in a large measure, determines the capacity of the ventilation system.

It has been found that in all vehicular tunnels the ventilation system is operating at a fractional capacity point, as much as 80 per cent of the time. It is therefore evident that full capacity operation is only used during an emergency.

Delicate instruments will automatically draw samples of air from the turnpike tunnels and analyze them for CO (carbon monoxide) content. The analyses are automatically recorded on an instrument chart.

It has been determined that a CO content of 4 parts in 10,000 should not be exceeded for general safety and reasonable comfort. This content has been found to produce no discomfort after a period of an hour. Therefore, the operating point was fixed below 4 parts per 10,000 in order to avoid discomfort to tunnel attendants who may be exposed for much longer periods than one hour.

Operation of vehicular tunnels has also demonstrated that in order to maintain clarity of atmosphere it is advisable to maintain a CO content approximating 2 parts in 10,000. CO content and clarity of atmosphere, however, are not related entities. In the turnpike tunnels it has been decided that a maximum of 4 parts of CO in 10,000 is satisfactory. It is interesting to note that in the Holland tunnel at New York the fans are running at one-half or one-quarter speed more than 80 per cent of the time. The horsepower required to drive them varies as the cube of the velocity and assuming, on this basis, that a given fan requires 64 hp. at full speed it will require only 8 hp. at one-half speed and only 1 hp. at one-quarter speed. Power consumption drops very rapidly with reduction in speed and therefore operating economy demands flexibility. This has been provided in the turnpike tunnels.

The fans, motors, and transmissions were purchased on a lump sum basis and, in addition, the guaranteed cost of operation was considered in awarding the contract. In order to establish the amount representing the cost of operation it was agreed in the contract that it would be determined by the following formula:

$$\text{Cost of operation (in dollars)} = \frac{H \times 1250}{8760}, \text{ in which}$$

H is the probable annual input of electrical energy in kilowatt-hours, the factor "*8760*" is the number of hours in one year, and the figure "*1250*" is the probable average cost in dollars, reduced to present value, of one kilowatt of electrical energy used continuously throughout the probable life time of the ventilation equipment. In order to determine the basis for arriving at input of electrical energy it is required that fan, motor, and transmission shop tests be run.

Since all the 26 fans of the turnpike tunnel ventilation system are of the same identical design, one of these fans will be built and tested very soon at all capacities and conditions. Similar tests will be run on the driving motors and speed transmissions to determine their compliance with the specification requirements as well as to determine their input characteristics and efficiencies.

With these combined data the cost of operation can be calculated in accordance with the method herein noted. If the cost of operation so determined exceeds the guaranteed cost, certain deductions can be made in the amount paid to the contractor. After the actual equipment installation is completed, a 90-day service operation test will be made to determine final compliance with all conditions and requirements of the contract.

The operation of the fans will be directed by a supervisor for each tunnel except in the case of Kittatinny and Blue Mountain tunnels, where controls will permit one supervisor for both tunnels. All tunnels will have two ventilation buildings, one at each portal, except Ray's Hill which, due to its shortness, will have only one ventilation building.

The supervisor of a tunnel will remotely control the ventilating equipment in the other portal building from his station. This permits uniform control of the air for each tunnel. The speed of each fan will be measured by an electrical tachometer and transmitted by wire to the supervisor's station.

Dampers will be provided to cut off each fan from the main air ducts. The ventilation duct is the space between the arch of the roof of the tunnel lining and the roadway ceiling slab. Ports in the ceiling slab at regular intervals will permit discharge of fresh air into the roadway section. From here the air current will discharge through the portals carrying with it the vitiated air. A bulkhead near the center of the tunnel in each air duct will separate the ventilating system of each tunnel into two parts, except Ray's Hill which has only one ventilation building.

The dampers will be automatically opened and closed, as the individual fans are started or stopped in accordance with a predetermined cycle of operation. Changes from one fan speed to another will be accomplished automatically by a method which will compensate for the differences in acceleration and deceleration caused by temperature changes and gaseous content. This method avoids undue stresses in the fans and drives of the equipment.

The ventilation buildings in addition to housing the fans and their drives and controls will also house power and lighting transformers, the CO recording apparatus, emergency lighting equipment, pumps for the roadway flushing system, well pumps, toilet facilities, heating equipment for these buildings, and other miscellaneous equipment. The buildings will be heated by vapor heating systems and automatic coal burners will be installed in the boilers.

Features in Design of a Typical Tangent Tunnel Approach

Inasmuch as the tunnels provide but two lanes it is necessary for a transition between the normal four-lane turnpike roadway and the two-lane tunnel roadway.

Tangent approaches were feasible at all but four of the fourteen tunnel portals. In these four cases the cost of construction of tangent approaches would have been prohibitive. In three of these cases the curvature of the approach continues several hundred feet inside the tunnel necessitating like curvature in this portion of the tunnel. In the fourth case the approach curvature stops a short distance outside the portal, being a 0 deg. 25 min. curve which is practically a tangent.

The length of transition is dictated by the necessity for allowing the in-bound traffic an appreciable length of time for making the change from two lanes to a single lane.

Tangent approaches are of two lengths, 1,000 ft. and 800 ft., the latter having been used only where 1,000 ft. of tangent could not be obtained.

The fast, or left hand, lane (facing the direction of traffic), see Figure 4, of the in-bound roadway continues directly into the tunnel. The slow, or right hand, lane tapers out, thus forcing traffic occupying it to shift over into the through lane. In the portion where shifting into one lane must be completed an extra width of shoulder has been provided. In addition the shoulder will be paved with 8 in. of coarse aggregate base and a bitumi-

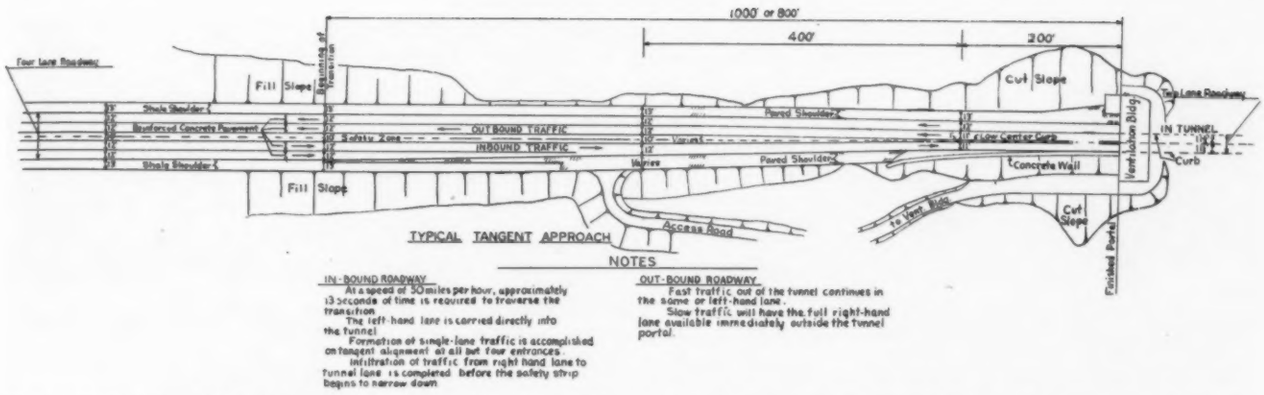

1000' or 800'
400'
200'
Four Lane Roadway
Beginning of Transition
Fill
Slope
Shale Shoulder
Reinforced Concrete Pavement
Safety Zone
OUT BOUND TRAFFIC
INBOUND TRAFFIC
Paved Shoulder
Varies
Cut
Slope
Two Lane Roadway
IN TUNNEL
Ventilation Bldg.
Curb
Concrete Wall
To Vent. Bldg.
Access Road
TYPICAL TANGENT APPROACH
Finished Portal
NOTES
IN-BOUND ROADWAY
At a speed of 50 miles per hour, approximately 13 seconds of time is required to traverse the transition.
The left-hand lane is carried directly into the tunnel.
Formation of single-lane traffic is accomplished on tangent alignment at all but four entrances.
Infiltration of traffic from right hand lane to tunnel lane is completed before the safety strip begins to narrow down.
OUT-BOUND ROADWAY
Fast traffic out of the tunnel continues in the same or left-hand lane.
Slow traffic will have the full right-hand lane available immediately outside the tunnel portal.

Fig. 4—Typical Transition of Roadbed from Four-Lane Superhighway to Two-Lane Road at Tunnel Portals of Pennsylvania Turnpike.

nous surfacing. A low wall, curved in plan, which forms a continuation of the tunnel wall and curb has been provided for two reasons: (1) to prevent falling rocks or other materials from rolling onto the roadway in front of the portal, and (2) to safeguard entry into the portal by eliminating any projections or surfaces at the portal which could cause damage to a car out of control.

A low, rounded, continuous curb starting where the center safety space has been narrowed to 5 ft. in width and extending to the portal will help to keep opposing traffic apart and thus aid in minimizing the danger of head-on collisions. Another feature which will help to accomplish the same purpose is an increase in roadway crown which starts about 275 ft. outside the portal and extends about the same distance into the tunnel. The crown increases from 1 in. in 11 ft. 6 in., which is standard for tunnels, to 2 5/16 in. in 11 ft. 6 in. maximum. The change is made in a longitudinal distance of 100 ft.

Out-bound traffic from the tunnel has been provided with two full lanes immediately on leaving the tunnel portal the left-hand lane (facing in the direction of traffic) having been made continuous with the tunnel lane. It is expected that fast traffic will use this lane and that the heavier, slower traffic will take advantage of the right-hand lane to pull over out of the way of the faster moving vehicles. The paved shoulder along the out-bound roadway affords an approach to the garage as well as space for stalled vehicles and maneuvering space for emergency equipment.

Tunnel Ventilation Buildings

Buildings are to be erected at each entrance of the seven tunnels. These buildings are to serve as tunnel entrance portals, see Figure 6, as well as for the housing of fans, motors, transmissions, and various other maintenance facilities.

By reason of the fact that roadways and bridges along the turnpike are being constructed of concrete, it was decided to use this material for these dual purpose buildings. They are to be identical in design. The design which has been selected is functional in style, without excess ornamentation of any kind. The exposed front of the building is to be made of architectural concrete; a rough texture being secured by staggering the form boards, leaving exposed random joints; this is for the purpose of avoiding the necessity of maintaining a smooth texture.

Reinforced concrete and steel is the construction to be used throughout; all floors to be concrete; partitions to be made of common brick; and roofs to be made of steel deck.

In the design of the buildings a problem arose because of the fact that the height of the tunnel ceilings will be only 14 ft. 4 in. Had this height been maintained out to the faces of the tunnel entrances, a motorist upon entering the tunnels would have experienced too sudden a transition from daylight to artificial light. In order to overcome this hazard, the entrances are to be flared both in width and height to a distance of 100 ft. back of the entrances. This flaring gives a 25 ft. height at the tunnel entrances, and by means of concentric arches and sloping ceilings, some daylight is admitted for a certain distance back of the entrances.

Fans.—Two large ventilating fans are to be placed directly over the entrance arches of the buildings. These are housed in a large room, the sides and back of which are louvred for the intake of air. In each building 1,200 sq. ft. of louvre area is required. No louvred space is permitted in the front wall because carbon monoxide fumes being forced out at the tunnel entrances would be drawn through them into the fans and recirculated in the tunnels. On a floor below the fan room is a large room for the installation of various electrical equipment which is necessary for the maintenance of the tunnels.

On the same level with the tunnel roadway and to one side there is provided space for a small heating plant, coal storage, sump pump, motor generator for tunnel emergency lighting system, and various other equipment. In this same space at one end of each tunnel provision is made for the storage of a towing truck; this truck to be used in case of wrecks or breakdowns of vehicles inside the tunnel.

The design of this building presented a most unusual problem for the reason that each building is practically buried in a mountain. The side walls and rear walls are figured to withstand the pressure of earth against them. As inside the tunnel, a drainage system will handle water which will seep from the mountain. In most cases the buildings are nestled at the bases of mountain saddles, which are about 700 ft. higher than the buildings. Naturally the mountains will tend to dwarf the buildings in scale. In the design which has been chosen much thought has been given to the matter of scale, and it is believed that this variation in scale has been largely overcome. At the top of each building the name of the tunnel will appear in leaded metal letters, supported on channel framing. The letters will be in front of a panel of glass, illuminated from the rear, which will make the name appear in silhouette.

Electrical Features for the Tunnels

One of the first questions to be decided regarding the electrical features of the tunnels was the source from

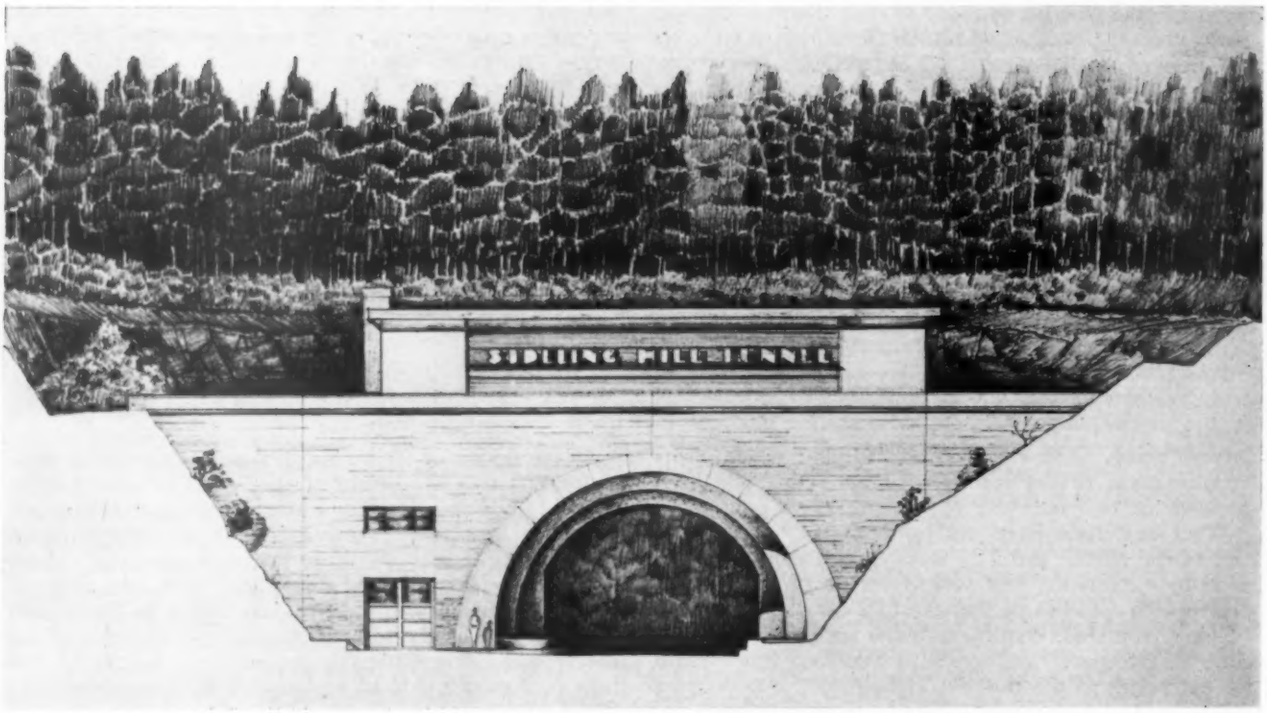


Fig. 5—Artist's Drawing of Typical Tunnel Portal and Ventilation Building.

which electric power would be supplied. Purchase of power from the public utility companies serving the territory adjacent to each of the tunnels would be generally more advantageous, from the point of view of economy, continuity of service, operation and maintenance, than including the cost of generating equipment as a part of the total electric system.

The number of tunnels to be served by a single power company is determined by their geographical location; that is, if they are located within the chartered territory of a specific company. Electric power and light service will be supplied at 13,200 volts to Blue Mountain, Kittatinny Mountain and Tuscarora Mountain tunnels; to Sideling Hill Mountain and Ray's Hill Mountain tunnels at 13,200 volts; to Allegheny Mountain Tunnel at 22,000 volts; and to the Laurel Hill Mountain Tunnel at 25,000 volts.

The commission extended three-phase 13,200 volt transmission lines in certain locations to meet those of the public utilities which are built partially along the turnpike right-of-way, across country, and over the mountains as a part of the electric system. Of very rugged design, they embody safety factors to withstand the severe winter conditions which necessarily will be encountered because of the mountainous section in which they are located. The lines are constructed of aluminum wire with a steel core to provide extra strength. They are supported on fir cross-arms 10 ft. in length attached to cedar poles including guys with wood strain insulators 6 ft. in length and porcelain insulators with a normal rating of 27,000 volts, providing a safety margin of 13,800 volts over the actual line voltage. This line is built in two separate sections, one from the east portal of Blue Mountain tunnel to Kittatinny Mountain tunnel, and continuing to the east portal of Tuscarora Mountain tunnel; the second, starting at the east portal of Sideling Hill tunnel and continuing to the east portal of Ray's Hill tunnel.

A tie line of the same voltage and standard of construction will be built between the east portal of Tuscarora Mountain tunnel and the east portal of Sideling Hill Mountain tunnel. In case of any power failure on the incoming lines of the company serving three tunnels, or of the company serving two tunnels, this line will provide the connecting link making either source of power available for service to all five tunnels. A double power circuit is provided by the power company supplying power to Allegheny Mountain tunnel so that duplicate service for this tunnel is also available as far as McDonaldton, a few miles away. Reliability of power is one of the most important points to be considered in laying out a tunnel electric system, especially for the lighting circuits, since a failure of illumination without warning would be even more serious than failure to provide proper ventilation, therefore, with two sources of power available, interruptions of service on the incoming power supply to the tunnels will be reduced to a minimum.

The high voltage lines terminate at six outdoor substations, adjacent to the portal buildings in which the dispatcher's office is located. At the substations step down transformers are installed with secondary voltages of 2,300, and suitable switching and protective equipment to disconnect the incoming supply in case of trouble.

The distance between Blue and Kittatinny Mountain Tunnels is but 650 ft., making it possible to supply electric service to both tunnels from one substation located at the west portal of Blue Mountain Tunnel. Both tunnels will be under the supervision of one dispatcher at the same location. Also at Ray's Hill Tunnel, because of its comparatively short length, it was possible to transmit all electric power requirements at 2,300 volts through the tunnel to the west portal, thereby providing service to all of the power equipment for this tunnel at a single location, and eliminating the building of a transmission line over the mountain between the two portals.

At all of the tunnels with the exception of Ray's Hill, power equipment is located within both portal buildings of each tunnel. This equipment is operated directly by

the dispatcher at the portal where the power is supplied and also at the opposite portal by remote control from the same location.

Considerable quantities of electric power will be required for the operation of the seven tunnels to supply the lighting, ventilation and other auxiliary equipment.

The lighting system is designed to provide continuous illumination with mercury vapor lamps throughout each tunnel with greater concentration at the portal entrance. This accomplishes as nearly as possible a duplication of daylight conditions for the driver of a vehicle entering the tunnel and allows the eye to become gradually adjusted to the artificial light. It will be the first mercury vapor highway lighting in the United States, it is claimed.

In case of an interruption in the incoming power and consequently in the tunnel lighting, a separate emergency lighting circuit using tungsten lamps has been installed throughout the length of each tunnel. Upon failure, lighting will be immediately restored by the automatic connection of the emergency lighting circuit with a large storage battery; if the failure is of approximately 10 sec. duration or longer the load will automatically be transferred from the battery to a small gasoline engine driven generating unit, which will continue to furnish illumination. Provision is also made to automatically disconnect the battery or generator after power has again been established on the incoming lines.

The power required will be used primarily at 2,300 and 440 volts, which is the maximum used within the tunnels, by the motors driving each of the ventilation fans. Four units, two at each portal, are installed for each tunnel, except at Ray's Hill, where only two units are required. For providing the required amounts of fresh air for ventilation under variable conditions the speed of all fans are independently adjustable. This is accomplished by the use of two motors connected through chain or speed reducers to drive a single fan; the large motor produces the maximum or 100 per cent speed, and the smaller two speed motor produces the 50 and 25 per cent speeds. Two main switches and magnetically controlled contactors for these motors are mounted on slate boards and housed in metal cubicles.

Another feature of interest relative to the operation of the ventilation fans is the method used to determine the amount of fresh air required in each tunnel, which varies in proportion with the volume of traffic. Volume of air delivered is proportional to fan speed. An automatic carbon monoxide analyzer is installed within each portal building, which electrically transmits a continuous graphic record of the carbon monoxide content at each sampling station within the tunnel, on a recorder mounted on the switchboard in the dispatcher's station. Sufficient fresh air is reqiured to keep the carbon monoxide less than four parts in ten thousand. The recorder is calibrated to read directly in parts of carbon monoxide in ten thousand. It is readily seen that since each tunnel with the exception of one, is equipped with four fans each with three speeds that, with so complete a selectivity of air output available, the dispatcher can meet all the requirements of fresh air for carbon monoxide control by increasing or decreasing the fan speed in proportion to the parts of carbon monoxide registered on the recorder.

The fan dampers, which resemble large sheet steel trap doors, are located in the air duct in front of each fan, and are automatically operated by electric motors and so arranged that they open or close at start or stop of the motor driving a given fan.

Tunnel Cross-Sectioning Instrument

In the original old tunnel survey work, to get cross-sectional areas as referred to a definite transit line, a special tunnel cross-sectioning instrument was employed. The method of employment is shown by the picture on the front cover of this issue. The rotating level was first used by the New Kanawa Power Co., at Glen Ferriss, W. Va., for use on some special tunnel work. Later this instrument was sold to the Pennsylvania Turnpike Commission.

It consists of a regulation 18 in. wye level, as shown by Fig. 6, which was designed to permit rotation of the telescope in the wyes and which has a graduated circle

Fig. 6—Special Cross-sectioning Level Used to Survey Driven Portions of Old Tunnel.

to measure the position of such rotation. In order that the rotation might be controlled, the level vial was mounted on the bar instead of being fastened to the telescope.

The vertical circle is attached to the telescope near the eye end. It is protected by a guard fastened to the wye, the guard carrying an index for reading the circle. The circle is graduated to half degrees, and figured 0-360 counter-clockwise, thus indicating a clockwise rotation of the telescope. A clamp is fitted over a special bearing on the telescope, this in turn being operated by a slow motion tangent screw. This permitted quick setting of the telescope, then a fine setting by means of this screw.

So far as is known, it is the only one of its kind.

▼

Bridge Design Competition for Students

The American Institute of Steel Construction has announced its annual bridge design competition for students in engineering and architectural schools throughout the United States. Prizes of $200, $100 and $50 respectively will be awarded for the designs judged to be first, second and third best. Certificates will be awarded to the prize winners and to those whose designs are given honorable mention. Drawings must be received not later than Feb. 5, 1940. Further particulars can be obtained from the Institute at 101 Park Ave., New York, N. Y.

▼

NATIONAL CONSTRUCTION INDUSTRY CONFERENCE—Rapid progress towards completion of plans for holding a National Construction Industry Conference in Washington this November is reported by E. P. Palmer, chairman of the Construction and Civic Development Committee of the Chamber of Commerce of the United States. A similar conference, held by the Chamber last fall, succeeded in centering public interest on the nation-wide need for stimulation of construction and pointed attention to obstacles standing in the way of increased building to meet national needs.

CONSTRUCTION PACES PROGRESS SCHEDULE

Project is Proving Ground for Methods, Equipment, Organization

CONSTRUCTION operations on the turnpike are "boom time" in character due to the rapidity necessary to complete the job before the termination of PWA, June 30, 1940. With all of the feverish activity, there is every indication that the various jobs have good supervision and organization. If there is the slightest indication that more speed is necessary, contractors do not hesitate to purchase new equipment.

After a bidder is awarded a contract he is required to submit a progress schedule to the commission. After approval of the progress schedule, it is used as a guide on progress of each contract. Figure 1 is a typical progress chart from which blank space has been eliminated. Table I is a compilation of the primary contracts. In making cross reference to other tabulations use the contract number as the key. The column headed "Section" refers to the numbered sections of the contracts as shown on the overall line plan on an insert sheet. In Table II is given a list of all subcontractors according to the primary contract on which he is working.

In explanation of Table III, Class I excavation consists of the removal and satisfactory disposal of all materials from within the limits of the approved cross-sections. It includes the widening of cuts and the flattening of slopes necessary for the construction and preparation of the roadbed, embankment, subgrade, shoulders, stream channels, intersections, approaches, removal of slides, and such other designed constructions as are necessary. Rock in cuts has to be taken out as planned, at least to the theoretical slope lines, from the ditch line to a height of 9 ft. above the ditch line. A tolerance of 12 in. is allowed outside of the theoretical slope line above the ditch line and a tolerance of 12 in. inside of the theoretical slope line above the point 9 ft. above the ditch line. All types of materials, rock, shale, clay, loam, etc., encountered within these limits are included in Class I excavation.

Class II excavation includes removal of all materials below the natural ground line and below the elevation of the finished roadway and its appurtenances as structures, pipe culverts of 36 in. internal diameter or larger, endwalls for such culverts, and old constructions below the grade line, which have to be removed. The furnishing and placing of shoring, cofferdams, etc., disposal of surplus material in the roadway embankments, and refilling of the areas around structures to the elevation of the adjacent surfaces is included in Class II excavation.

Borrow excavation consists of material excavated wholly outside of the designed limits of the roadway. It must be furnished by the contractor in the bid price. If it is obtained within the limits of the turnpike by widening cut sections, payment is made for it as Class I excavation instead of borrow, if the former is less.

Class A concrete is structural concrete. It is discussed in the section on "Roadway" under the head of "Materials."

Class B concrete is a leaner mix with different water-cement ratio. Along with paving slab concrete it, also, is discussed in the "Roadway" section under the head of "Materials."

Plain steel bars and plain structural steel must meet the requirements for the products as established by the A.S.T.M.

Table III is a tabulation of bid prices by contract number for these various items.

A resumé of the project may be quickly obtained from Table IV. In preparing the table it was neces-

(*Continued on page* 91)

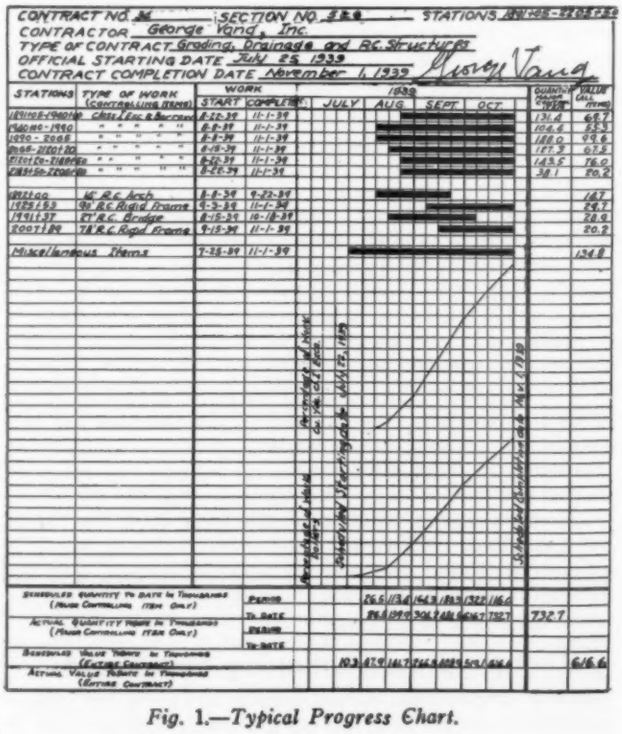


Fig. 1.—Typical Progress Chart.

TABLE I.—LIST OF CONTRACTS AS AWARDED BY THE PENNSYLVANIA TURNPIKE COMMISSION

Contract No.	*Section*	*Name of Contractor and Address*	*Date Awarded*	*Amount of Contract*	*Type of Construction*	*Calendar Days*	*Length Feet*
1	19	L. M. Hutchison Mount Union, Pa.	10-27-38	$458,058	Structures Grading and Drainage	275	50,371
2	11 & 12	Girard Construction Co., Inc. Philadelphia, Pa.	11-29-38	$444,758	Structures Grading and Drainage	230	50,476
3	19-A	C. T. Burket Vineland, N. J.	12-20-38	$115,627	Structures Grading and Drainage	220	3,647
4	7-B & 8-A	Connell and Laub Dayton, Ohio	1-4-39	$605,113	Structures Grading and Drainage	200	35,376
5	19-B	M. Edward Wilt and Sons Millersburg, Pa.	2-17-39	$29,884	Structures Grading and Drainage	135	1,304
6	15 & 16	C. J. Langenfelder and Son Rosedale, Balto. Co., Md.	2-17-39	$418,813	Structures Grading and Drainage	180	36,490
7	4	Guthrie-Marsch-Peterson Co. Chicago, Ill.	3-1-39	$505,091	Structures Grading and Drainage	250	9,418
8	15-A	Nello L. Teer Durham, N. C.	3-14-39	$132,495	Structures Grading and Drainage	100	15,438
9	13 & 14	Empire Construction Company Baltimore, Md.	3-14-39	$773,918	Structures Grading and Drainage	225	28,786
10	8-C & 9-A	County Construction Company Carnegie, Pa.	3-20-39	$663,164	Structures Grading and Drainage	130	39,862
11	2	McCrady Construction Co. Pittsburgh, Pa.	6-7-39	$354,072	Structures Grading and Drainage	120	15,181
12-S-2	S2	Arundel Corporation Baltimore, Md.	4-3-39	$2,444,527	Sideling Hill Tunnel and East and West Approaches	315	13,337
13-L2	L2 L2	Hunkin-Conkey Construction Co. Cleveland, Ohio	4-3-39	$1,920,281	Laurel Hill Tunnel and East and West Approaches	315	12,618
14	8B-2	Connell and Laub Const. Co. Dayton, Ohio	4-27-39	$240,532	Structures Grading and Drainage	100	16,110
15	16-A & 17	L. M. Hutchison Mount Union, Pa.	4-27-39	$429,781	Structures Grading and Drainage	115	29,231
16	4-A	Frank Mashuda Milwaukee, Wis.	4-27-39	$582,711	Structures Grading and Drainage	100	21,666
17	A2	Guthrie-Marsch-Peterson Co. Chicago, Ill.	5-12-39	$2,672,188	Allegheny Tunnel and East and West Approaches	315	9,816
18	KB2	Bates and Rogers Chicago, Ill.	5-12-39	$2,920,123	Kittatinny and Blue Mt. Tunnel and East and West Approaches	315	12,400
19		B. F. Sturtevant Boston, Mass.	5-4-39	$217,330 operating cost $96,360	Fans; Motors and Transmission	315	
20	13-B	York Engineering Co. York, Pa.	5-4-39	$326,209	Viaduct and Grading and Drainage	200	4,071
21	13-C	York Engineering Co. York, Pa.	5-4-39	$315,406	Structures Grading and Drainage	115	13,050
22		Hen Johnston, Inc. West Reading, Pa.	5-4-39	$5,336	172 Unlighted Signs, 7 Lighted Signs	30	
23	3-B	Ferguson and Edmondson Co. Pittsburgh, Pa.	5-12-39	$364,864	New Stanton Viaduct and Grading and Drainage	160	1,901
24	R-2	Mason and Hanger Co. New York City	5-24-39	$1,549,718	Ray's Hill Tunnel and East and West Approaches	295	7,008
25	T-2	B. Perini and Sons, Inc. Framingham, Mass.	5-24-39	$2,055,939	Tuscarora Tunnel and East and West Approaches	295	10,847
26	3-A & 4-C	Guthrie-Marsch-Peterson Co. Chicago, Ill.	5-24-39	$709,957	Structures Grading and Drainage	130	34,429
27	13-E	N. R. Corbisello Binghamton, N. Y.	7-20-39	$882,710	Structures Grading and Drainage	210	5,076
28	12-B & 13-A	M. Bennett & Sons Indiana, Pa.	5-24-39	$496,532	Dunning Creek Viaduct Grading and Drainage	200	6,825
29	18	C. J. Langenfelder & Son Rosedale, Md.	6-7-39	$731,466	Structures Grading and Drainage	120	50,352
30	S4	To Be Advertised			Ventilation Buildings East and West Sideling Hill Tunnel	250	

TABLE I—LIST OF CONTRACTS—(Continued)

Contract No.	*Section*	*Name of Contractor and Address*	*Date Awarded*	*Amount of Contract*	*Type of Construction*	*Calendar Days*	*Length Feet*
31	L4A	To Be Advertised			Ventilation Buildings East Laurel Hill Tunnel	250	
32	2-B & 3A1	Ferguson and Edmondson Co. Pittsburgh, Pa.	6-7-39	$489,540	Structures Grading and Drainage	120	22,845
33	5-A	Adam Eidemiller Greensburg, Pa.	6-7-39	$699,588	Structures Grading and Drainage	120	27,920
34	5 & 6	George Vang, Inc. Pittsburgh, Pa.	6-7-39	$616,596	Structures Grading and Drainage	100	29,166
35	11-B	N. B. Putman Co. Harrisburg, Pa.	6-19-39	$164,955	Structures Grading and Drainage	100	600
36	8C1 & 9A1	H. R. Dickens Philadelphia, Pa.	6-19-39	$138,466	Structures Grading and Drainage	90	1,497
37	16-B	Dalton Bros., Inc. Paoli, Pa.	6-19-39	$234,593	Structures Grading and Drainage	90	10,373
38	18A & 19C	H. W. Shaull & Son Mechanicsburg, Pa.	6-19-39	$287,833	Structures Grading and Drainage	100	26,000
39	19-D	Walker Bros. Chambersburg, Pa.	7-20-39	$886,027	Paving Contract Structures—Grading R. C. Pavement	175	54,278
40	2-C	Baldwin Bros. Paving Co. Cleveland, Ohio	7-6-39	$415,736	Structures Grading and Drainage	110	7,286
41	9C2, 10 & 11A	Central Pa. Quarry Stripping and Const. Co., Hazelton, Pa.	7-6-39	$1,561,920	Structures Grading and Drainage	165	38,385
42	8B-1	Connell & Laub Const. Co. Dayton, Ohio	7-6-39	$642,295	Structures Grading and Drainage	150	14,520
43	12A	Herman Holmes Crystal Falls, Mich.	7-20-39	$1,513,504	Structures Grading and Drainage	150	37,646
44	13D	Nello L. Teer Durham, N. C.	7-6-39	$795,244	Structures Grading and Drainage	140	17,846
45	15B	Holt-McConnel and Osburn Cannonsburg, Pa.	7-20-39	$52,222	Structures Grading and Drainage	100	1,770
46	19E & 20	John H. Swanger Lancaster, Pa.	8-1-39	$1,114,324	Paving; Structures Grading and Drainage	280	35,355
47	20A	Johnson, Drake and Piper, Inc. Freeport, L. I.	8-1-39	$1,213,588	Paving; Structures Grading and Drainage	280	28,411
48	14A	L. M. Hutchison Mount Union, Pa.	8-1-39	$487,420	Structures Grading and Drainage	220	14,362
49	7P1 & 8P1	Shullo Construction Co. Akron, Ohio	8-1-39	$681,650	R. C. Pavement Grading	270	41,533
50	8P4 & 9P1	Union Paving Company Philadelphia, Pa.	8-1-39	$730,711	R. C. Pavement Grading	270	42,897
51	15P1 & 16P1	John F. Bloomer Appleton, Wis.	9-8-39	$833,194	R. C. Pavement; Structures Grading and Drainage	260	40,143
52	T4	To Be Advertised			Ventilation Buildings East and West Tuscarora Tunnel	220	
53	K4 & B4A	To Be Advertised			Ventilation Buildings East and West Kittatinny Tunnel W. Blue Mt. Tunnel	220	
56	8P3	Union Paving Co. Philadelphia, Pa.	9-8-39	$265,975	R. C. Pavement, Grading and Drainage	260	16,065
57	11P1 & 12P1	County Const. Co. Carnegie, Pa.	9-8-39	$823,457	R. C. Pavement, Grading and Drainage	260	50,624
58	16P2 & 17P1	N. B. Putman Harrisburg, Pa.	9-8-39	$596,634	R. C. Pavement, Grading and Drainage	260	31,684
59	15P2	W. L. Johnson Const. Co. Hicksville, Ohio	9-8-39	$382,441	R. C. Pavement, Grading and Drainage	260	20,275
60	2P1 & 3P1	William D. Vogel Indianapolis, Ind.	9-25-39	$423,060	R. C. Pavement, Grading and Drainage	240	22,845
61	16P3	N. B. Putman Harrisburg, Pa.	9-25-39	$240,132	R. C. Pavement, Grading and Drainage	240	10,965

NOTE.—Feet of Construction Pertains Only to Turnpike Distances and Not Distances for Side Road Construction, Which Is Included in Amount of Contract.

TABLE II.—LIST OF SUB-CONTRACTORS

Contract No.	*Section*	*Contractor and Job Address*	*Sub-Contractor and Job Address*	*Date Approved*	*Amount of Contract*	*Type of Work*
1	19	L. M. Hutchinson R.D. No. 2, Newville, Pa.	None			
2	11 & 12	Girard Const. Co. Pennsylvania Hotel Bedford, Pennsylvania	Penn Wayne, Inc. Manns Choice, Pa.	4-24-39	$69,000	Bridges
3	19A	C. T. Burket Box No. 94, Newville, Pa.	D. S. Warfel Box No. 94, Newville, Pa.	1-12-39	$65,879	Excavation and Conc. Structure
4	7B & 8A	Connell & Laub Peoples Bank Building Somerset, Pennsylvania	None			
5	19B	M. E. Wilt & Son Central Inn Shippensburg, Pa.	D. M. Stoltzfus & Son Talmage, Pa.	3-22-39	$6,500	Excavating and Grading
6	15 & 16	C. J. Langenfelder Hustontown, Pa.				
7	4	Guthrie-Marsch-Peterson Company Mt. Pleasant, Pa.	H. E. Ramsey Pittsburgh, Pa.	6-19-39	$1,880	Guard Rail
			Pitt. Ply-Rite Co., Inc. Pittsburgh, Pa.	6-19-39	$2,500	Waterproofing
8	15A	Nello L. Teer Everett, Pa.	H. F. Blough Johnstown, Pa.	6-14-39	$23,442	Two Concrete Arches and One Bridge
9	13 & 14	Empire Const. Co. Box No. 87, Everett, Pa.	John F. Keeler Green Lane, Pa.	5-2-39	$111,145	Structures
			Reed & Kuhn Elysburg, Pa.	5-2-39	$74,701	Structures
10	8C & 9A	County Const. Co. Box No. 422 Somerset, Pa.	None			
11	2	McCrady Const. Co.	G. A. & T. M. Wagman Dallastown, Pa.	7-14-39	$126,000	Grading and Drainage
			John Mays, Jr. 475 Onedia St., Mt. Washington, Pitt., Pa.	8-1-39	$1,650	Erecting Reinforcing
12	S2	Arundel Corporation	None			
13	L2	Hunkin-Conkey Const. Co. 135 W. Main St. Somerset, Pa.	Hinman Bros. Denver, Colo.	5-5-39	$295,000	Approaches
14	8B-2	Connell & Laub	Howes & Farrell, Inc. Sidney Center, N. Y.	6-15-39	$53,609	Class II Excavation and Concrete Structures
15	15A & 17	L. M. Hutchinson Burnt Cabins, Pa.	None			
16	4A	Frank Mashuda Acme, Pa.	A. R. Coffeen Decorah, Iowa	5-15-39	$130,614	Structures
			Fayette Roofing Company Uniontown, Pa.	7-6-39	$1,260	Waterproofing
			C. S. Bossart Mt. Pleasant, Pa.	8-9-39	$5,768	Inlets and Grouted Spillway
17	A2	Guthrie-Marsh-Peterson Co. Box M, Berlin, Pa.	None			
18	KB2	Bates & Rogers Roxbury Hotel Roxbury, Pa.	Samons-Robertson Co. and Boxley Brothers, Inc. Huntingdon, W. Va.	6-15-39	$450,000	Open Cut and Tunnel Excavation
			H. O. Brechbiel & Son Orange, Va.	6-7-39	$8,500	Construction Field Office
			Asheville Contracting Co. Chambersburg, Pa.	6-15-39	$135,000	Clearing and Grubbing
19		B. F. Sturtevant Boston, Mass.	None (Fans, Motors, and Transmissions)			
20	13B	York Engr. & Const. Co. Bedford, Pa.	Phoenix Bridge Co. Phoenixville, Pa.	7-11-39	$88,563	Furnishing and Erection of Steel Structures
21	13C	York Engr. & Const. Co. Bedford, Pa.	None			
22		Hen Johnson Company West Reading, Pa.	None			
23	3B	Ferguson & Edmondson Pittsburgh, Pa.	None			

TABLE II.—LIST OF SUB-CONTRACTORS—(Continued)

Contract No.	*Section*	*Contractor and Job Address*	*Sub-Contractor and Job Address*	*Date Approved*	*Amount of Contract*	*Type of Work*
24	R2	Mason & Hanger New York	George Vang, Inc. Grant Bldg., Pitt., Pa.	7-6-39	$153,000	Grading and Drainage of App. Open Cut Tunnel Excavation Clearing and Grubbing
			Everett Lumber Co. Everett, Pa.	7-5-39	$6,800	Erection of Field Office
			W. V. Pangborne Co. 1927 W. Montgomery Ave. Philadelphia, Pa.	7-8-39	$12,742	Installation of Power Line
25	T2	B. Perini & Sons Framingham, Mass.	Carnegie Lumber Co. Fulton Bldg., Pitt., Pa.	6-30-39	$4,950	Construction Field Office
			W. V. Pangborne & Co. Philadelphia, Pa.	6-26-39	$41,245	Construction Power Line
26						
27						
28						
29	18	C. J. Langenfelder Baltimore, Md.	Bethlehem Steel Co. Bethlehem, Pa.	7-31-39	$23,920	Furnish and Erect Steel Struct.
30	S4	Ritter Bros. Harrisburg, Pa.				
31	L4A	Ritter Bros. Harrisburg, Pa.				
32	2B & 3A1	Ferguson & Edmondson Keystone Bldg. Pittsburgh, Pa.	Dodd Constr. Company Spencer, W. Va.	7-6-39	$96,000	Concrete Structures
			Marshall Co. 225 E. 15th St., Dover, O.	7-6-39	$96,000	Concrete Structures
			Zambano & Sons 309 Brown Av., Greensburg	7-6-39	$43,000	Concrete Structures
			Conte Eastwood Pittsburgh, Pa.	7-6-39	$240,000	Grading and Drainage
33	5A	Adam Eidenmiller Greensburg, Pa.	Eau Claire Engr. Company Eau Claire, Wis.	8-31-39	$125,000	Concrete Structures
			Ralph W. Fimple Fairmount, W. Va.	7-31-39	$225,000	Class I Excavation
			Carnegie Lumber Co. Fulton Bldg., Pitt., Pa.	8-9-39	$1,375	Lumber for Field Office
34	5 & 6	George Vang, Inc. Pittsburgh, Pa.	Corrodo & Galiardi Const. 2nd National Bank Bldg. Pittsburgh, Pa.	7-7-39	$100,000	Grading and Drainage
			Tri State Engr. Co. Washington, Pa.	7-7-39	$100,000	Grading and Drainage
35	11-B	N. B. Putman Harrisburg, Pa.				
36	8C1 & 9A1	H. R. Dickens Philadelphia, Pa.	Mignotti Constr. Co. 333 Ashbourne Rd. Melrose Park, Pa.	8-8-39	$28,087	Grading and Drainage
			Raymond Conc. Pile Co. 140 Cedar St., N. Y.	8-8-39	$8,370	Concrete Piles
37	16B	Dalton Bros. Paoli, Pa.	Reed & Kuhn 321 N. Spring St. Everett, Pa.	8-3-39	$41,086	Concrete Structures
			Bethlehem Steel Co. Bethlehem, Pa.	7-7-39	$27,660	Structural Steel
			John F. Keeler Green Lane, Pa.	9-6-39	$35,103	Concrete Structures
38	18A & 19C	H. W. Shaull & Son Mechanicsburg, Pa.	None			
39	19D	Walker Bros. Irwin, Pa.	M. E. Wilt & Son Millersburg, Pa.	8-9-39	$45,000	Concrete Structures
40	2C	Baldwin Bros. Irwin, Pa.	Pitt. Const. Co. Pittsburgh, Pa.	8-8-39	$125,000	Viaduct and Underpass (Arona Bridge)
			O. C. Cluss Lumber Co. Uniontown, Pa.	8-16-39	$1,845	Field Office
41	9C2, 10 & 11A	Central Pa. Q., S. & Construction Co. Hazelton, Pa.	A. A. White Lebanon, Pa.	7-31-39	$192,146	Grading and Drainage
			J. H. Wickersham Lancaster, Pa.	8-22-39	$160,497	Structures and Bridges

(*Continued on page* 87)

TABLE II—LIST OF SUB-CONTRACTORS—(Continued from page 82)

No. Contract	Section	Contractor and Job Address	Sub-Contractor and Job Address	Date Approved	Amount of Contract	Type of Work
42	8B1	Connell & Laub Const. Co. Dayton, Ohio				
43	12A	Herman Holmes Crystal Falls, Mich.	Ray McCarty Kaukava, Wis.	8-29-39	$98,000	Concrete Structures
			Jacobson & McKinley Pittsburgh, Pa.	8-29-39	$60,000	Grading
			Roy E. Furman Waynesburg, Pa.	8-29-39	$128,000	Concrete Structures
			The Aldwyn Corp. Bryn Mawr, Pa.	8-29-39	$90,863	Bridges
			Harman Bros. Elkins, W. Va.	8-29-39	$35,000	Concrete Structures
			The McKenzie Co. Dearborn, Mich.	8-29-39	$100,000	Grading
44	13D	Nello L. Teer Durham, N. C.	T. A. Loving Co. Goldsboro, N. C.	8-29-39	$201,811	Concrete Structures
45	15B	Holt, McConnel & Osburn Canonsburg, Pa.	Bethlehem Steel Co. Bethlehem, Pa.	8-25-39	$10,350	Struct. Steel Erection
46	19E & 20	Johnson, Drake & Piper Carlisle, Pa.	E. A. Daylor Coatsville, Pa.	8-29-39	$178,894	Concrete Structure
47	20A	Johnson, Drake & Piper Carlisle, Pa.	Hempt Bros. Camp Hill, Pa.	8-23-39	$22,000	Black Top Pavement
			American Bridge Company Camp Hill, Pa.	8-23-39	$10,000	Steel Struct. Erected

TABLE III—QUANTITIES AND UNIT PRICE BID

Contract No.	Description	Quantities	Unit Price Bid
1	Class 1 Excavation	831,256 cu. yd.	$ 0.26
	Class 2 Excavation	13,909 cu. yd.	1.25
	Borrow Excavation	11,145 cu. yd.	0 27
	Class A Concrete	3,026 cu. yd.	18.00
	Class B Concrete	5,709 cu. yd.	14.00
	Plain Steel Bars	492,751 lb.	0.04
	Plain Structural Steel	2,115 lb.	0.10
2	Class 1 Excavation	673,532 cu. yd.	0.29
	Class 2 Excavation	12,865 cu. yd.	1.25
	Borrow Excavation	118,145 cu. yd.	0.20
	Class A Concrete	1,987 cu. yd.	17.50
	Class B Concrete	5,394 cu. yd.	14.50
	Plain Steel Bars	501,988 lb.	0 05
	Plain Structural Steel	13,882 lb.	0.10
3	Class 1 Excavation	121,536 cu. yd.	0.28
	Class 2 Excavation	2,956 cu. yd.	1.25
	Borrow Excavation	11,368 cu. yd.	0.28
	Class A Concrete	1,462 cu. yd.	17.00
	Class B Concrete	2,254 cu. yd.	14.00
	Plain Steel Bars	288,008 lb.	0 04
	Plain Structural Steel	205 lb.	0.10
4	Class 1 Excavation	1,121,529 cu. yd.	0.35
	Class 2 Excavation	8,317 cu. yd.	1.20
	Borrow Excavation	16,832 cu. yd.	0.22
	Class A Concrete	1,361 cu. yd.	20.00
	Class B Concrete	2,828 cu. yd.	17.00
	Plain Steel Bars	348,864 lb.	0 05
	Plain Structural Steel	2,255 lb.	0.10
5	Class 1 Excavation	25,450 cu. yd.	0.27
	Class 2 Excavation	1,079 cu. yd.	1.25
	Borrow Excavation	2,154 cu. yd.	0.30
	Class A Concrete	140 cu. yd.	17.75
	Class B Concrete	772 cu. yd.	13.50
	Plain Steel Bars	63,017 lb.	0 04
	Plain Structural Steel	22,364 lb.	0.0475
6	Class 1 Excavation	859,876 cu. yd.	0.29½
	Class 2 Excavation	9,718 cu. yd.	1.25
	Borrow Excavation	12,237 cu. yd.	0.25
	Class A Concrete	2,909 cu. yd.	16.50
	Class B Concrete	1,902 cu. yd.	12.50
	Plain Steel Bars	510,963 lb.	0 04
	Plain Structural Steel	330 lb.	0.10
7	Class 1 Excavation	806,561 cu. yd.	0.39
	Class 2 Excavation	8,454 cu. yd.	1.50
	Borrow Excavation	6,831 cu. yd.	0.39
	Class A Concrete	3,097 cu. yd.	21.00
	Class B Concrete	3,653 cu. yd.	17.00
	Plain Steel Bars	384,948 lb.	0.045
	Plain Structural Steel	.....	....
8	Class 1 Excavation	222,503 cu. yd.	0.28
	Class 2 Excavation	2,793 cu. yd.	1.50
	Borrow Excavation	3,394 cu. yd.	0.28
	Class A Concrete	86 cu. yd.	19.00
	Class B Concrete	1,132 cu. yd.	17.00
	Plain Steel Bars	66,947 lb.	0.05
	Plain Structural Steel	.....	...
9	Class 1 Excavation	1,297,434 cu. yd.	0.34
	Class 2 Excavation	8,675 cu. yd.	1.75
	Borrow Excavation	4,667 cu. yd.	0.30
	Class A Concrete	4,613 cu. yd.	22.00
	Class B Concrete	4,644 cu. yd.	17.00
	Plain Steel Bars	812,919 lb.	0.045
	Plain Structural Steel	2,007 lb.	0.15
10	Class 1 Excavation	832,939 cu. yd.	0.35
	Class 2 Excavation	10,886 cu. yd.	2.00
	Borrow Excavation	20,552 cu. yd.	0 35
	Class A Concrete	5,262 cu. yd.	20.00
	Class B Concrete	4,962 cu. yd.	18.00
	Plain Steel Bars	1,055,612 lb.	0.045
	Plain Structural Steel	3,177 lb.	0.10

TABLE III—QUANTITIES AND UNIT PRICE BID—(Continued)

Contract No.	*Description*	*Quantities*	*Unit Price Bid*
11	Class 1 Excavation	404,060 cu. yd.	0.37
	Class 2 Excavation	8,091 cu. yd.	1.75
	Borrow Excavation	30,768 cu. yd.	0.30
	Class A Concrete	2,184 cu. yd.	24.50
	Class B Concrete	2,753 cu. yd.	18.00
	Plain Steel Bars	570,669 lb.	0.05
	Plain Structural Steel	.....	...
12-S2	Excav. Loose Mat. Prev. Driv. Area	12,800 cu. yd.	2.00
	Excav. of Tunnel in Prev. Undriven Area	93,000 cu. yd.	5.70
	Excav. of Tunnel in Prev. Driven Area	31,200 cu. yd.	5.70
	Excav. Enlargement of Tunnel-Order.-Eng.	1,000 cu. yd.	5.70
	Open Cut Tunnel Excavation	25,000 cu. yd.	0.55
	Concrete Masonry—Tun. Lining	34,600 cu. yd.	16.00
	Concrete Masonry—Tun. Ceiling	3,400 cu. yd.	26.00
	Concrete Masonry—Pavement	16,920 sq. yd.	3.60
	Reinforcing Rods	1,830,000 lb.	0.06
13-L2	Excav. Loose Mat. Previously Driv. Area	600 cu. yd.	5.69
	Excav. of Tunnel in Previously Undriven Area	98,200 cu. yd.	5.69
	Excav. of Tunnel in Previously Driven Area	8,270 cu. yd.	5.69
	Excav. Enlargement of Tunnel-Order.-Eng.	1,000 cu. yd.	5.69
	Open Cut Tunnel Excavation	44,400 cu. yd.	2.26
	Concrete Masonry — Tunnel Lining	22,830 cu. yd.	13.00
	Concrte Masonry — Tunnel Ceiling	2,000 cu. yd.	17.50
	Concrete Masonry—Pavement	11,163 sq.yd.	3.00
	Reinforcing Rods	1,200,000 lb.	0.041
14	Class 1 Excavation	369,746 cu. yd.	0.29
	Class 2 Excavation	3,794 cu.yd.	1.30
	Borrow Excavation	1,683 cu. yd.	0.28
	Class A Concrete	860 cu. yd.	20.00
	Class B Concrete	1,982 cu. yd.	17.00
	Plain Steel Bars	295,440 lb.	0.05
	Fabricated Structural Steel	218,000 lb.	0.062
15	Class 1 Excavation	724,340 cu. yd.	0.28½
	Class 2 Excavation	11,794 cu. yd.	1.50
	Borrow Excavation	2,345 cu. ld.	0.28½
	Class A Concrete	1,452 cu. yd.	19.00
	Class B Concrete	6,656 cu. yd.	16.00
	Plain Steel Bars	482,549 lb.	0.04
	Plain Structural Steel	8,290 lb.	0.10
16	Class 1 Excavation	653,752 cu. yd.	0.60
	Class 2 Excavation	6,129 cu. yd.	1.90
	Borrow Excavation	.....	...
	Class A Concrete	2,392 cu. yd.	23.50
	Class B Concrete	1,787 cu. yd.	17.60
	Plain Steel bars	424,975 lb.	0.0475
	Plain Structural Steel	.....	...
17	Excavation of Tunnel	162,500 cu. yd.	5.85
	Excav. Enlargement of Tunnel-Order.-Eng.	1,000 cu. yd.	7.25
	Open Cut Tunnel Excavation	47,000 cu. yd.	2.25
	Concrete Masonry—Tun. Lining	30,100 cu. yd.	13.00
	Concrete Masonry—Tun. Ceiling	2,750 cu. yd.	18.00
	Concrete Masonry—Pavement	15,080 sq. yd.	2.30
	Reinforcing Rods	1,500,000 lb.	0.045
18	Excav. Loose Mat. in Prev. Driven Area	13,000 cu. yd.	6.15
	Excav. of Tunnel in Prev. Undriv. Area	43,000 cu. yd.	6.15
	Excav. of Tunnel in Prev. Driven Area	75,000 cu. yd.	6.15
	Excav. Enlargement of Tunnel-Order-Eng.	2,000 cu. yd.	6.15
	Open Cut Tunnel Excavation	83,000 cu. yd.	1.45
	Concrete Masonry—Tun. Lining	48,500 cu. yd.	10.15
	Concrete Masonry—Tun. Ceiling	4,410 cu. yd.	20.50
	Concrete Masonry—Pavement	22,260 sq. yd.	2.75
	Reinforcing Rods	2,800,000 lb.	0.04
19	Lump Sum Bid for Fans, Motors and Transmission	$217,330.00	
	Guaranteed Cost of Operation for Lifetime	$ 96,360.00	
20	Class 1 Excavation	186,904 cu. yd.	0.40
	Class 2 Excavation	3,817 cu. yd.	2.00
	Borrow Excavation	8,680 cu. yd.	0.10
	Class A Concrete	3,120 cu. yd.	19.00
	Class B Concrete	2,419 cu. yd.	17.00
	Plain Steel Bars	639,527 lb.	0.045
	Fabricated Structural Steel	1,481,000 lb.	0.0675
21	Class 1 Excavation	363,838 cu. yd.	0.35
	Class 2 Excavation	5,978 cu. yd.	1.50
	Borrow Excavation	8,662 cu. yd.	0.10
	Class A Concrete	2,072 cu. yd.	19.00
	Class B Concrete	4,678 cu. yd.	17.00
	Plain Steel Bars	325,927 lb.	0.045
	Plain Structural Steel	6,342 lb.	0.12
22	Construction Signs for All Contracts — 172 Unlighted Signs, Lighted Signs.		
23	Class 1 Excavation	70,759 cu. yd.	0.45
	Class 2 Excavation	6,657 cu. yd.	2.50
	Borrow Excavation	.....	...
	Class A Concrete	6,628 cu. yd.	30.00
	Class B Concrete	1,842 cu. yd.	19.00
	Plain Steel Bars	1,209,481 lb.	0.047
	Fabricated Structural Steel	58,450 lb.	0.075
24	Excav. Loose Mat. in Prev. Driven Area	10,500 cu. yd.	7.20
	Excav. Tunnel in Prev. Undriven Area	27,650 cu. yd.	7.20
	Excav. Tunnel in Prev. Driven Area	25,200 cu. yd.	7.20
	Excav. Enlargement of Tunnel-Order.—Eng.	1,000 cu. yd.	7.20
	Open Cut Tunnel Excavation	40,000 cu. yd.	2.00
	Concrete Masonry—Tun. Lining	17,500 cu. yd.	12.00
	Concrete Masonry—Tun. Ceiling	1,650 cu. yd.	20.00
	Concrete Masonry—Pavement	8,690 sq. yd.	3.60
	Reinforcing Rods	950,000 lb.	0.05
25	Excav. Loose Mat. in Prev. Driven Area	8,820 cu. yd.	6.30
	Excav. Tunnel in Prev. Un-Driven Area	40,090 cu. yd.	6.30
	Excav. Tunnel in Prev. Driven Area	36,740 cu. yd.	6.30
	Excav. Enlargement of Tunnel-Order.-Eng.	1,000 cu. yd.	6.30
	Open Cut Tunnel Excavation	30,000 cu. yd.	6.30
	Concrete Masonry—Tun. Lining	26,250 cu. yd.	10.75
	Concrete Masonry—Tun. Ceiling	2,510 cu. yd.	22.00
	Concrete Masonry—Pavement	13,200 sq.yd.	2.50
	Reinforcing Rods	1,500,000 lb.	0.04
26	Class 1 Excavation	692,465 cu. yd.	0.39
	Class 2 Excavation	11,435 cu. yd.	2.00
	Borrow Excavation	54,563 cu. yd.	0.39
	Class A Concrete	3,478 cu. yd.	24.00
	Class B Concrete	6,317 cu. yd.	20.00
	Plain Steel Bars	731,976 lb.	0.045
	Plain Structural Steel	9,524 lb.	0.10
	Fabricated Structural Steel	412,800 lb.	0.07
27	Class 1 Excavation	1,126,942 cu. yd.	0.46
	Class 2 Excavation	11,815 cu. yd.	1.60
	Borrow Excavation	.....	...
	Class A Concrete	7,369 cu. yd.	20.00
	Class B Concrete	6,701 cu. yd.	18.00
	Plain Steel Bars	1,075,428 lb.	0.045
	Plain Structural Steel	860 lb.	0.10
28	Class 1 Excavation	293,259 cu. yd.	0.52
	Class 2 Excavation	11,282 cu. yd.	2.00
	Borrow Excavation	23,184 cu. yd.	0.20
	Class A Concrete	4,061 cu. yd.	20.00
	Class B Concrete	4,775 cu. yd.	17.00
	Plain Steel Bars	628,464 lb.	0.045
	Fabricated Structural Steel	1,451,500 lb.	0.065

TABLE III—QUANTITIES AND UNIT PRICE BID—(Continued)

Contract No.	Description	Quantities	Unit Price Bid
29	Class 1 Excavation	816,441 cu. yd.	0.34
	Class 2 Excavation	22,712 cu. yd.	1.50
	Borrow Excavation	174,101 cu. yd.	0.28
	Class A Concrete	2,903 cu. yd.	19.00
	Class B Concrete	10,274 cu. yd.	14.00
	Plain Steel Bars	1,065,808 lb.	0.04
	Plain Structural Steel	10,958 cu. yd.	0.08
	Fabricated Structural Steel	382,300 cu. yd.	0.063
30	Portal Bldg., to Be Readvertised.		
31	Portal Bldg., to Be Readvertised.		
32	Class 1 Excavation	523,141 cu. yd.	0.35
	Class 2 Excavation	7,255 cu. yd.	2.00
	Borrow Excavation	12,187 cu. yd.	0.35
	Class A Concrete	3,475 cu. yd.	24.00
	Class B Concrete	3,994 cu. yd.	20.00
	Plain Steel Bars	777,583 lb.	0.05
	Plain Structural Steel	4,200 lb.	0.10
33	Class 1 Excavation	925,857 cu. yd.	0.47
	Class 2 Excavation	7,794 cu. yd.	2.50
	Borrow Excavation	5,037 cu. yd.	0.50
	Class A Concrete	1,612 cu. yd.	23.00
	Class B Concrete	3,500 cu. yd.	20.00
	Plain Steel Bars	525,368 lb.	0.05
	Plain Structural Steel	4,350 lb.	0.10
34	Class 1 Excavation	656,164 cu. yd.	0.53
	Class 2 Excavation	5,599 cu. yd.	2.25
	Borrow Excavation	76,494 cu. yd.	0.53
	Class A Concrete	1,102 cu. yd.	28.00
	Class B Concrete	1,895 cu. yd.	22.00
	Plain Steel Bars	343,371 lb.	0.05
	Plain Structural Steel	.....	...
35	Class 1 Excavation	17,420 cu. yd.	0.30
	Class 2 Excavation	3,566 cu. yd.	1.50
	Borrow Excavation	69,094 cu. yd.	0.30
	Class A Concrete	1,295 cu. yd.	21.00
	Class B Concrete	4,069 cu. yd.	18.00
	Plain Steel Bars	460,357 lb.	0.04
	Plain Structural Steel	8,535 lb.	0.10
36	Class 1 Excavation	17,212 cu. yd.	0.45
	Class 2 Excavation	2,757 cu. yd.	2.50
	Borrow Excavation	40,914 cu. yd.	0.38
	Class A Concrete	370 cu. yd.	28.00
	Class B Concrete	2,027 cu. yd.	17.50
	Plain Steel Bars	226,757 lb.	0.035
	Fabricated Structural Steel	702,000 lb.	0.055
37	Class 1 Excavation	360,178 cu. yd.	0.27
	Class 2 Excavation	4,358 cu. yd.	1.50
	Borrow Excavation	5,932 cu. yd.	0.27
	Class A Concrete	293 cu. yd.	22.00
	Class B Concrete	2,774 cu. yd.	20.00
	Plain Steel Bars	190,274 lb.	0.05
	Fabricated Structural Steel	461,000 lb.	0.06
38	Class 1 Excavation	486,172 cu. yd.	0.25
	Class 2 Excavation	6,841 cu. yd.	1.50
	Borrow Excavation	6,811 cu. yd.	0.30
	Class A Concrete	1,215 cu. yd.	19.00
	Class B Concrete	2,816 cu. yd.	17.00
	Plain Steel Bars	320,356 lb.	0.04
	Fabricated Structural Steel	.....	...
39	Class 1 Excavation	39,640 cu. yd.	0.35
	Class 2 Excavation	2,556 cu. yd.	1.50
	Borrow Excavation	16,588 cu. yd.	0.30
	Class A Concrete	569 cu. yd.	20.00
	Class B Concrete	1,658 cu. yd.	17.00
	Plain Steel Bars	216,516 lb.	0.04
	Fabricated Structural Steel	.....	...
40	Class 1 Excavation	282,100 cu. yd.	0.44
	Class 2 Excavation	7,727 cu. yd.	1.25
	Borrow Excavation	.....	...
	Class A Concrete	985 cu. yd.	26.00
	Class B Concrete	5,262 cu. yd.	24.00
	Plain Steel Bars	609,370 lb.	0.055
	Plain Structural Steel	2,425 cu. yd.	0.08
	Fabricated Structural Steel	1,014,000 cu. yd.	0.05
41	Class 1 Excavation	1,964,819 cu. yd.	0.57
	Class 2 Excavation	11,134 cu. yd.	2.25
	Borrow Excavation	.....	...
	Class A Concrete	4,208 cu. yd.	21.00
	Class B Concrete	6,158 cu. yd.	18.00
	Plain Steel Bars	920,840 lb.	0.045
	Plain Structural Steel	7,150 lb.	0.085
42	Class 1 Excavation	203,978 cu. yd.	0.35
	Class 2 Excavation	12,053 cu. yd.	1.50
	Borrow Excavation	296,216 cu. yd.	0.35
	Class A Concrete	2,550 cu. yd.	22.00
	Class B Concrete	9,218 cu. yd.	19.00
	Plain Steel Bars	947,191 lb.	0.04
	Plain Structural Steel	98,257 lb.	0.044
	Fabricated Structural Steel	1,225,000 lb.	0.051
43	Class 1 Excavation	1,491,151 cu. yd.	0.54
	Class 2 Excavation	18,817 cu. yd.	1.50
	Borrow Excavation	16,733 cu. yd.	0.50
	Class A Concrete	5,360 cu. yd.	22.00
	Class B Concrete	12,723 cu. yd.	20.00
	Plain Steel Bars	1,618,012 lb.	0.04
	Fabricated Structural Steel	1,989,000 lb.	0.055
44	Class 1 Excavation	859,332 cu. yd.	0.60
	Class 2 Excavation	11,537 cu. yd.	1.75
	Borrow Excavation	.....	...
	Class A Concrete	1,991 cu. yd.	19.00
	Class B Concrete	6,496 cu. yd.	17.00
	Plain Steel Bars	637,128 lb.	0.04
	Plain Structural Steel	4,025 lb.	0.10
45	Class 1 Excavation	28,296 cu. yd.	0.47
	Class 2 Excavation	935 cu. yd.	1.50
	Borrow Excavation	859 cu. yd.	0.45
	Class A Concrete	89 cu. yd.	21.50
	Class B Concrete	721 cu. yd.	19.50
	Plain Steel Bars	73,564 lb.	0.0425
	Fabricated Structural Steel	180,000 lb.	0.0675
46	Class 1 Excavation	418,550 cu. yd.	0 60
	Class 2 Excavation	6,473 cu. yd.	2.00
	Borrow Excavation	.....	...
	Class A Concrete	3,017 cu. yd.	22.00
	Class B Concrete	4,844 cu. yd.	18.00
	Plain Steel Bars	842,572 lb.	0.04
	Plain Structural Steel	3,200 lb.	0.08
	Fabricated Structural Steel	1,123,000 cu. yd.	0.068
47	Class 1 Excavation	459,989 cu. yd.	0.60
	Class 2 Excavation	8,455 cu. yd.	1.50
	Borrow Excavation	276,837 cu. yd.	0.40
	Class A Concrete	3,994 cu. yd.	21.00
	Class B Concrete	6,168 cu. yd.	17.00
	Plain Steel Bars	1,177,329 lb.	0.045
	Fabricated Structural Steel	197,000 lb.	0.065
48	Class 1 Excavation	485,491 cu. yd.	0.39
	Class 2 Excavation	9,204 cu. yds.	1.50
	Borrow Excavation	10,929 cu. yd.	0.20
	Class A Concrete	1,477 cu. yd.	23.00
	Class B Concrete	6,304 cu. yd.	19.00
	Plain Steel Bars	759,010 lb.	0.04
	Plain Structural Steel	2,944 lb.	0.10
	Fabricated Structural Steel	426,000 lb.	0.065
49	Class 1 Excavation	95 cu. yd.	0.50
	Class 2 Excavation	355 cu. yd.	2.00
	Borrow Excavation	4,338 cu. yd.	0.50
	Class A Concrete	.....	...
	Class B Concrete	189 cu. yd.	20.00
	Plain Steel Bars	7,200 lb.	0.05
	Plain Structural Steel	.....	...
50	Class 1 Excavation	.....	...
	Class 2 Excavation	173 cu. yd.	2.50
	Borrow Excavation	.....	...
	Class A Concrete	.....	...
	Class B Concrete	181 cu. yd.	20.00
	Plain Steel Bars	7,200 lb.	0 06
	Plain Structural Steel	.....	...

TABLE III—QUATITIES AND UNIT PRICE BID—(Continued)

Contract No.	*Description*	*Quantities*	*Unit Price Bid*
51	Class 1 Excavation	40,212 cu. yd.	0.60
	Class 2 Excavation	1,206 cu. yd.	2.50
	Borrow Excavation	2,309 cu. yd.	0.50
	Class A Concrete	190 cu. yd.	26.00
	Class B Concrete	1,768 cu. yd.	20.00
	Plain Steel Bars	129,160 lb.	0.045
	Fabricated Structural Steel	148,500 lb.	0.07
52	Portal Bldg. to Be Readvertised.		
53	Portal Bldg. to Be Readvertised.		
56	Class 1 Excavation	17 cu. yd.	1.00
	Class 2 Excavation	91 cu. yd.	2.00
	Borrow Excavation	759 cu. yd.	0.60
	Class A Concrete	.....	...
	Class B Concrete	4 cu. yd.	25.00
	Plain Steel Bars	.....	...
	Plain Structural Steel	.....	...
57	Class 1 Excavation	6,949 cu. yd.	0 80
	Class 2 Excavation	166 cu. yd.	2.00
	Borrow Excavation	.....	...
	Class A Concrete	.....	...
	Class B Concrete	21 cu. yd.	30.00
	Plain Steel Bars	.....	...
	Plain Structural Steel	.....	...
58	Class 1 Excavation	43 cu. yd.	1.00
	Class 2 Excavation	285 cu. yd.	2.00
	Borrow Excavation	.....	...
	Class A Concrete	.....	...
	Class B Concrete	5 cu. yd.	30.00
	Plain Steel Bars	.....	...
	Plain Structural Steel	.....	...
59	Class 1 Excavation	2,686 cu. yd.	0.60
	Class 2 Excavation	205 cu. yd.	2.00
	Borrow Excavation	110 cu. yd.	0.40
	Class A Concrete	.....	...
	Class B Concrete	362 cu. yd.	20.00
	Plain Steel Bars	14,400 lb.	0.05
	Plain Structural Steel	.....	...
60	Class 1 Excavation	806 cu. yd.	0.50
	Class 2 Excavation	252 cu. yd.	2.00
	Class B Concrete	10 cu. yd.	30.00
	Plain Structural Steel	.....	...
61	Class 1 Excavation	56 cu. yd.	1.00
	Class 2 Excavation	70 cu. yd.	3.00
	Class B Concrete	7 cu. yd.	30.00
	Plain Structural Steel	.....	...

TABLE IV—TABULATION OF DATA PERTAINING TO ALIGNMENT AND GRADES FROM WESTERN TERMINUS ONE MILE EAST OF IRWIN TO EASTERN TERMINUS AT MIDDLESEX

Division	—Tangents— No.	Length, Feet	Horizontal Curves—Number, Degree, Length in Feet— No.	1°	No.	2°	No.	3°	No.	4°	No.	5°	No.	6°	Total Lengths
1-A—															
Mt. Pleasant	59	109,565.27	9	7,768.04	19	23,103.92	14	13,663.73	11	13,120.91	2	2,611.90	..	.....	169,835.77 ft. 32.17 mi.
1—															
Somerset	47	108,562.44	6	10,979.31	6	11,014.89	12	14,641.86	13	11,960.05	3	2,254.41	7	7,516.81	166,929.76 ft. 31.62 mi.
2—															
Everett	47	133,245.72	13	26,937.23	20	26,352.13	11	19,743.87	1	1,038.75	1	2,759.63	..	.....	210,077.33 ft. 39.78 mi.
3—															
Shippensburg	42	223,108.54	9	35,647.24	11	14,252.86	14	15,714.70	4	5,660.09	1	1,918.03	..	.....	296,301.46 ft. 56.12 mi.
Totals	195	574,481.97	37	81,331.82	56	74,725.80	51	63,764.16	29	31,779.80	7	9,543.97	7	7,516.81	843,144.32 ft.
Miles		108.803		15.404		14.153		12.076		6.019		1.808		1.424	159.69

Division	—Grades—Length in Feet— 0.5%	1%	2%	3%	Vertical Curves Length in Feet Algebraic Difference 1 to 3	3 to 6	Total Lengths
1-A—							
Mt. Pleasant	5,267.50	14,118.88	22,721.48	66,642.41	33,300.00	27,786.00	169,835.77 ft. 32.17 mi.
1—							
Somerset	3,950	36,407.91	14,658.50	59,313.35	23,850.00	28,750.00	166,929.76 ft. 31.62 mi.
2—							
Everett	42,659.10	36,857.65	9,155.66	47,449.92	34,800.00	39,155.00	210,077.33 ft. 39.78 mi.
3—							
Shippensburg	32,527.32	74,906.28	21,350.99	40,816.87	65,107.44	61,592.56	296,301.46 ft. 56.12 mi.
Totals	84,403.42	162,290.72	67,886.63	214,222.55	157,057.44	157,283.56	843,144.32 ft.
Miles	15.99	30.74	12.86	40.57	29.74	29.79	159.69 mi.

Total number of tangents	195
Total number of curves	187
Total miles of curves	50.89
Total miles of tangents	108.80
Total miles	159.69

	Miles
Total grade length	100.16
Total vertical curves	59.53
Total miles	159.60

Note:

Horizontal Curves	1° 0° to 1°30′	2° 1°30′ to 2°30′	3° 2°30′ to 3°30′	etc.
Grades	0.5% 0% to 0.5%	1% 0.5% to 1.5%	2% 1.5% to 2.5%	3% 2.5% to 3%

(Continued from page 78)

Fig. 2.—Inside View of Tunnel Work Showing Steel Roof Arches and Wall Columns in Place on East Portal Kittatinny Mountain.

sary to group the curves and grades for compactness. For example, all horizontal curves from 0 deg. to 1 deg. 30 min., inclusive, were classified as 1 deg., from there up to 2 degs. 30 min., curves were called 2 degs., etc. A similar plan was used on the grades.

Procedure on Some Tunnels.—Due to the character of the rock, like the east side of Laurel Hill tunnel, contractors are not mucking the entire cross-section and placing steel ribs as they go. Instead, they are projecting three man size holes from the portal face into the rock on a line parallel with the center line. These holes are about 4 ft. by 6 ft. One is located on each side of the cross-section near the junction of the arch roof break line and the side wall break lines. The third is located at the center near the crown of the arch break line.

These holes are driven about a hundred feet into the rock and then cross connections drilled and lightly shot in the cubical shale to the arch break line. The arch is carried beyond the spring line about a foot to provide a bearing for the roof-arch steel. Then working outward, the area above a line joining the intersection of the arch with the walls (like the string on an archer's bow) is shot and arch steel placed. The muck, of course, is removed through the mansize holes with wheelbarrows and the roof lagged above the steel. This continues clear to the portal.

A working space at the back end is then dug down in stepped offsets to the base line of the arch support columns on each side. This provides room to work. Then a gallery is excavated along each wall, to the rock neat wall line, and wall columns set in place under each end of the arched roof steel. A seat is fabricated near each end of the arch steel to transfer the load to the column tops. Naturally, the gallery must be made wide enough for men to operate wheelbarrows and so that column steel can be brought in.

In the original design of the arch steel, variable weights from 18 lb. to 40 lb., 8 in., I-beams were planned as indicated by the character and attitude of the rock strata. Later designs called for a uniform weight, 18-lb. steel. During construction in some places, after the 18-lb. steel was in place and the roof shored, it was discovered that the weight had to be increased so that now, 40-lb. steel is being used. The

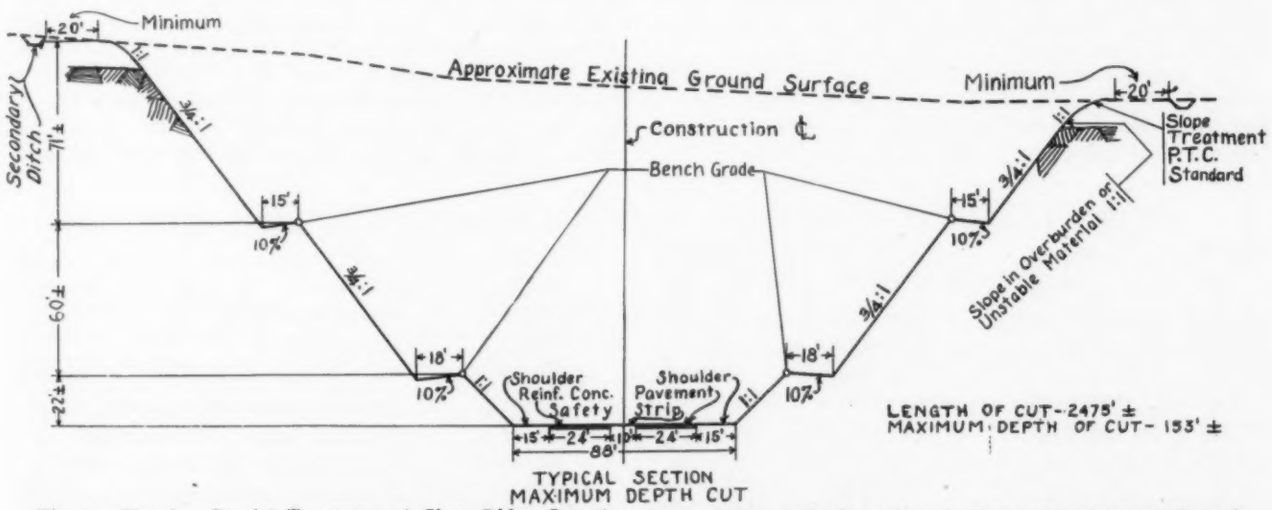


Fig. 3.—Showing Special Treatment of Clear Ridge Cut, the Largest Cut on the Turnpike. It Replaced a Proposed Tunnel.

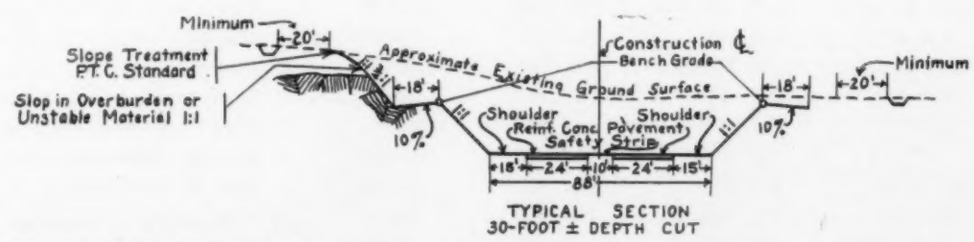


Fig. 3a.—Typical Cross Section of Average Cut. Included to Show Comparison with Deepest Cut.

unexcavated central portion served excellently as a supporting base for shoring while making the steel changes.

Largest Cut, Clear Ridge—In Bedford County, 1¼ mi. east of Everett, is the site of the Clear Ridge cut which is one of the heaviest excavation sections. This rock cut will replace the heretofore proposed Clear Ridge tunnel which was to have been 1,700 ft. in length. The location is known as Section 13E, Contract No. 27, under contract to N. R. Corbisello, Binghampton, N. Y., covering the overall distance of 0.96 miles. The cut at its deepest point is approximately 153 ft. and it is 2,475 ft. in length. The total amount of excavation involved will be approximately 1,150,000 cu. yd. Special designing was necessary for a large cut of this nature, as shown by Fig. 3. By the use of benching, the engineers have reduced to a minimum the danger of falling rocks, slides, and the cost of maintenance over a period of years. These benches lend aid in landscaping this cut for prevention of erosion.

Inasmuch as this location was originally the proposed Clear Ridge tunnel site, the engineers, after a through study proved a general reduction in costs over tunnel construction and operating expenses by using an open cut. This is due to the ratio between tunnel construction unit prices plus operation costs, and the unit prices of open cut excavation involved. The total width of roadway will be 88 ft. and the distance from top of cut on one side to the top of cut on the opposite side will be approxmiately 435 ft. The use of secondary ditches back of the slopes and the benches in the cut will prove as excellent drainage facilities, as these features will be constructed with a suitable grade. See Table V for data on other large cuts and fills. Figure 3A is included to show the variation of the deepest cut, from the average cut.

Largest Blast.—On the evening of Sept. 4, 1939, Labor Day, the largest blast in the construction of the Pennsylvania Turnpike was set off by the Empire Construction Co. on Section 13-14, Bedford County.

The area between stations 1475 and 1480 had been drilled vertically with 2070 holes, 24 ft. deep, spaced 5½ ft. center to center, using a 2¾ in. tapered wagon type air drill driven by a 440 cu. ft. compressor.

The enormous size of this blast can best be explained by the fact that 42,700 lb. of dynamite were used. This amount is equivalent to approximately 21½ tons or 2⅛ freight car loads. Three portable light plants were used to furnish the necessary power to explode the charge. Ordinary blasting batteries were not used due to the large number of drilled holes.

The blasting operation was under the supervision of Col. Jack Edwards, Superintendent of Explosives for the Empire Construction Co. The shot was completed with such perfection that the material heaved and settled with little, if any, flying debris. Compared to the size of the blast there was comparatively little sound in the near vicinity, but the concussion and rumble were felt and heard for a distance of five miles. It is estimated that approximately 50,000 cu. yd. of material was loosened by the explosion.

Naturally, protection was necessary for the "A" and "B" cables of the American Telephone & Telegraph Co., which spanned the cut. Each cable carried 608 wires serving newspapers, radio, private lines and the stock exchange. The cables were covered and released from their position on the poles and in turn were suspended by ropes. As a precaution the A. T. & T. Co. had two service trucks with necessary equipment at the location to repair any damage which might have occurred to the cables. However, due to the lack of flying debris, no damage whatever occurred.

Progress.—It is estimated that grading and drainage at this writing is 65 per cent complete. Since the specifications prohibit the deposition of frozen soil in fills, the contractors took the overburden earth excavation out first. Practically the whole length of the project has rock or shale in the cuts.

Naturally some time is required after a contract award, for the contractor to assemble necessary equipment on the job. The engineers planned to have funds available according to a predetermined schedule. Since this phase had to be established before operations began, funds accumulated before they were earned. By referring to Fig. 4 it will be noted that in February, 1939, about $180,000 worth of work had been done when it was expected that about $260,000 worth would be earned. Actual earnings lagged behind schedule until

TABLE V.—TABULATION OF DEEPEST CUTS AND FILLS ALONG TURNPIKE ROUTE

Cont. No.	*Section No.*	*Length in Ft.*	*Depth in Ft.*	*Cu. Yd.*	*Location*
7	4	Cut 2200	Cut 91	540,000	Mt. Joy
7	4	Cut 1300	Cut 47	155,000	One mile east of Mt. Joy
7	4	Fill 1650	Fill 75	390,000	Brush Creek
7	4	Fill 900	Fill 60	241,000	One mile east of Mt. Joy
4	7B & 8A	Cut 1250	Cut 82	269,000	Replacing Quemahoming tunnel
10	8C & 9A	Cut 1575	Cut 67	296,000	Replacing Negro Mountain tunnel
41	9C2, 10 & 11A	Cut 750	Cut 95	208,000	Two miles east of Allegheny tunnel
41	9C2, 10 & 11A	Cut 930	Cut 78	266,000	East of New Baltimore
41	9C2, 10 & 11A	Fill 875	Fill 71	171,000	East of Allegheny tunnel
41	9C2, 10 & 11A	Fill 820	Fill 78	278,000	Two miles west of New Baltimore
9	13 & 14	Cut 2400	Cut 63	165,000	One mile east of Clear Ridge
27	13E	Cut 2475	Cut 153	1,150,000	Clear Ridge
9	13 & 14	Fill 600	Fill 86	180,000	½ mile east of Clear Ridge
9	13 & 14	Fill 700	Fill 77	160,000	West Providence Township
1	19	Cut 1205	Cut 49	162,000	Between Newburg-Roxbury
15	16A & 17	Cut 1500	Cut 42	136,000	West of Burnt Cabins
6	15 & 16	Fill 890	Fill 52	140,000	Fort Littleton
1	19	Fill 470	Fill 46	41,000	North of Newburg

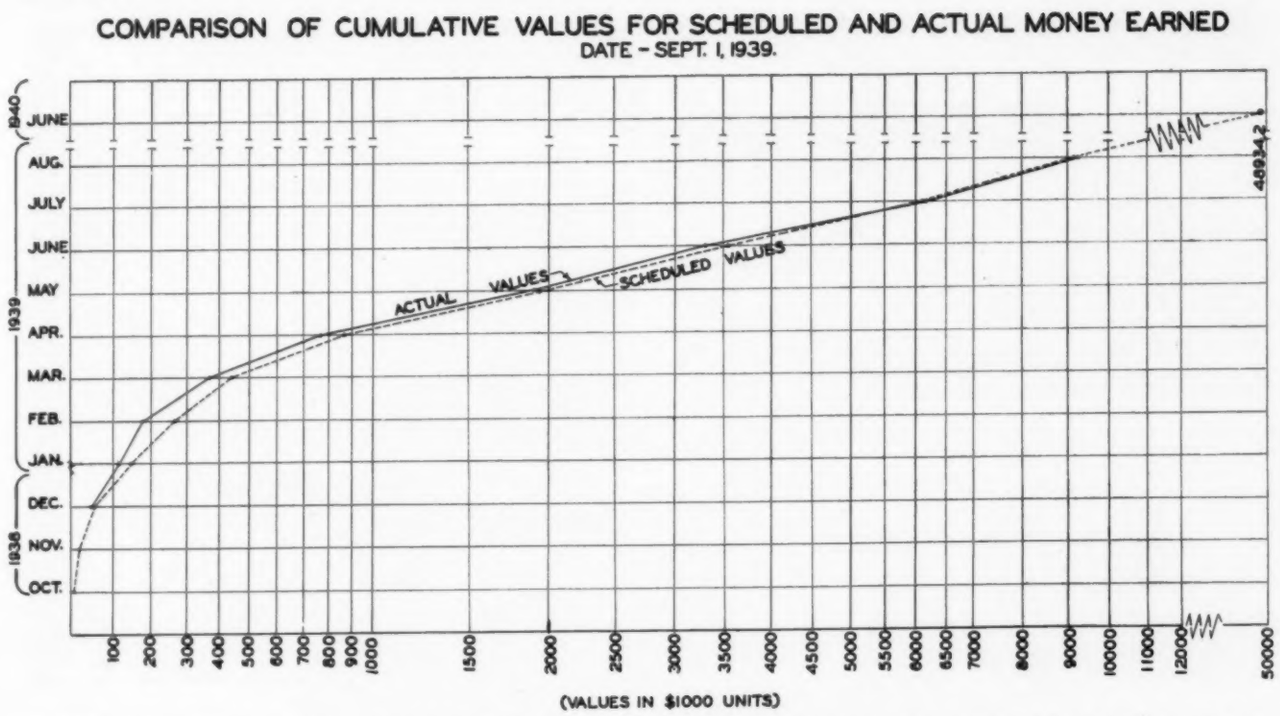


Fig. 4.—Comparison Between Moneys Scheduled and Moneys Earned. Rate of Production Crossed Scheduled Funds About July. This Shows That Contractors Have Enough Operating Equipment on the Job to Complete the Project on Time.

about July, 1939. At present, the rate of construction on the job as a whole is greater than the rate of scheduled earnings, which indicates that contractors have accomplished the necessary tempo.

From Table VI a quick picture of the total approximate quantities involved may be obtained.

Slope Rounding.—At the intersection of the cut slopes with the natural ground the cut slope must be rounded. Definite curvatures of rounding has been adopted as shown in Table VII. This part of the work is usually done after the cut gets down a few feet.

TABLE VI.—APPROXIMATE TOTAL QUANTITIES FOR TURNPIKE CONSTRUCTION

ROADWAY

Length 153.24 mi. (tunnel excluded)

Excavation, Class 1, 2, and Borrow	24,549,740	cu. yd.
Steel including structural, reinforcing bars, roadway mesh and miscellaneous steel	29,475	net tons
Reinforced concrete paving	4,300,000	sq. yd.
Macadam paving	150,000	sq. yd.
Concrete (9 in. thick)	4,300,000	sq. yd.
Bridge surface (2½ in. thick)	46,672	sq. yd.
Class A	95,000	cu. yd.
Class B	176,500	cu. yd.
Cement	2,115,260	bbls.
Sand	641,058	cu. yd.
Crushed stone	1,153,225	cu. yd.

TUNNELS

6.76 mi. total length of all tunnels

Excavation including tunneling and materials for sub-grade	763,070	cu. yd.
Concrete including paving, sidewalks, grout	245,025	cu. yd.
Cement	501,350	bbls.
Sand	104,840	cu. yd.
Stone	205,280	cu. yd.
Steel including structural, reinforcing bars and mesh, miscellaneous steel	16,130	tons

TABLE VII.—CUT SLOPE TREATMENT

Cut Slope 1:1 *Ground Slope + or —	Natural ground variable Curve
+ 1½ : 1	6°
+ 2 : 1	6°
+ 2½ : 1	6°
+ 3 : 1	10°
+ 4 : 1	10°
+ 6 : 1	10°
Level	20°
— 6 : 1	20°
— 4 : 1	20°
— 3 : 1	20°
— 2 : 1	20°

*Plus slope up and away from road.
Minus slope down and away from road.

Equipment

On the following pages an effort has been made to list the major equipment on each primary contract by number and type. Subcontractor's equipment is included with that of the primary contractor. This information was obtained directly from the contractors or their superintendents on the job. Before the project is completed, it is estimated that over $30,000,000 worth of equipment will have been at work. Contractors are to be commended for the amount of new equipment they put to work.

Trend of equipment development, as exemplified on this job, is toward larger, faster hauling units, and larger quantities of excavation per unit. Several new units, if they stand up to the demands of this rocky work and can conform in unit cost of output with competitive proved equipment, will find a place on future construction projects. The contracts listed in Table I, which are not shown on the following pages, were not started when this was written.

Contract No. 1

On L. M. Hutchison Contract, State Officials Inspect Finished Grade.

EQUIPMENT LIST

5 Power shovels, ⅜ to 2 yd.; 3 Tractors and bulldozers; 3 Tractors and scrapers, 12 yd.; 2 Motor graders, 12 ft.; 15 Trucks, 2 yd., end dump; 3 Trucks, 12 yd., end dump; 3 Air compressors; 3 Wagon drills; 4 Rollers, 10 ton; 1 Tractor, large; 1 Concrete mixer; 2 Pavers, 27E; 2 Centrifugal pumps, 4 in.; 4 Concrete vibrators.

• •

Contract No. 2

Girard Construction Co., Inc., Starting Cut in Easy Terrain.

EQUIPMENT LIST

2 Power shovels, 1½ and 2 yd.; 5 Rollers, 10 ton; 15 Trucks, 1½ to 5 ton, end dump; 3 Tractors and scrapers, 10 yd.; 4 Tractors and bulldozers; 1 Tractor, crawler, small; 3 Motor graders, 12 ft.; 2 Compressors, 120 cu. ft.; 1 Wagon drill; 5 Vibrators, concrete; 2 Light plants, small; 4 Pumps, centrif., 3 in.; 1 Pump, diaph., 4 in.

• •

Contract No. 3

C. T. Burket Handles Concrete from Mixer to Form with Concrete Bucket and Crane.

EQUIPMENT LIST

1 Power crane, 1 yd.; 1 Tractor and scraper, 12 yd.; 1 Tractor and scraper, 7½ yd.; 1 Roller, 10-ton; 1 Motor grader, 12 ft.; 1 Paver, 27E; 1 Pump, force; 2 Pumps, centrifugal, 2 in.; 1 Pump, double diaphragm, 4 in.; 1 Compressor, 120 cu. ft.

• •

Contract No. 4

On Connell and Laub's First Contract. Quemahoning Cut Replaces Old South Penn Tunnel at Left.

EQUIPMENT LIST

12 Power shovels, ¾ to 2 yd.; 4 Motor graders, 12 ft.; 6 Tractors and bulldozers; 13 Rollers, 10 ton; 25 Tractors and scrapers, 12 yd.; 12 Wagons, truck type, 8 yd., bottom dump; 3 Trucks, 4 yd., end dump; 6 Tractor-trucks, 6 yd., end dump; 12 Trucks, 1½ yd., end dump; 5 Compressors, 160 to 315 cu. ft.; 3 Wagon drills; 8 Truck transit mixers, 2½ yd.; 1 Paver, 27E, 4 Vibrators, concrete.

• •

Contract No. 5

M. Ed. Wilt and Son Did a Nice Job on This 45-deg. Skew T-Beam (Span 22 ft. 4 in.) Underpass.

EQUIPMENT LIST

It was not possible to obtain this equipment from the field before the job was done. The following minimum equipment submitted by the contractor was tentatively accepted by the Commission:

1 Power shovel, ⅜ yd.; 1 Roller, 10 ton; 1 Grader; 1 Mixer, 7 s.

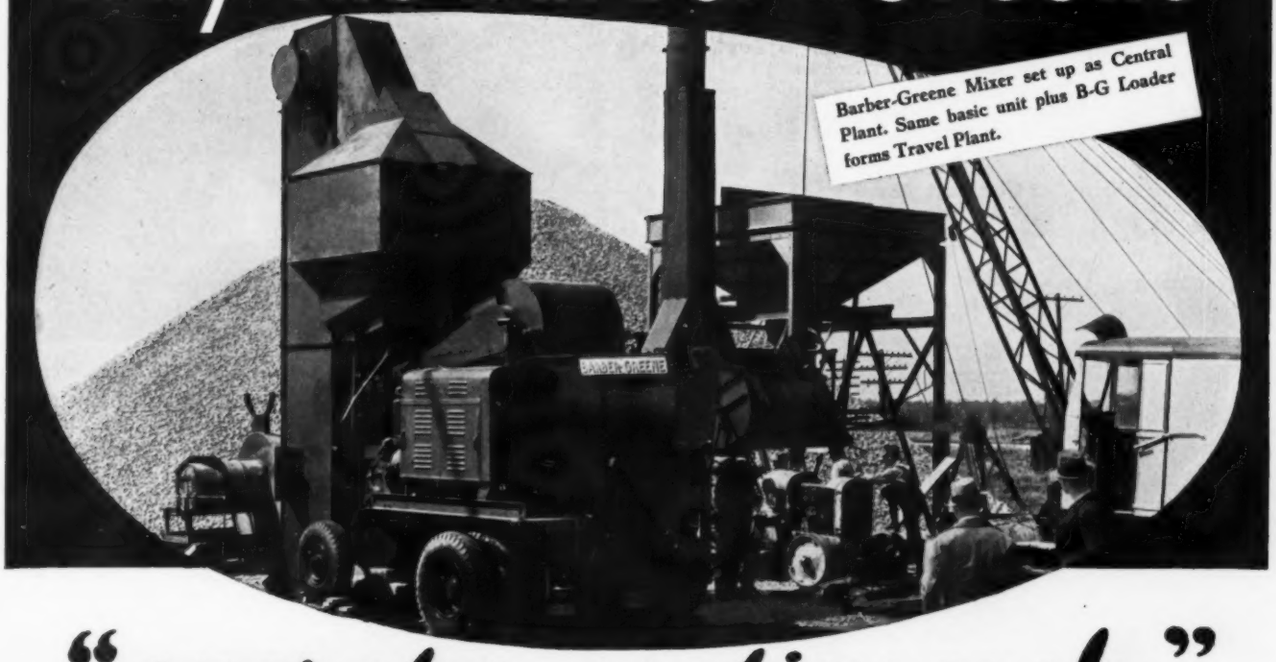
However, there was much more equipment used than listed here.

• •

Contract No. 6

C. J. Langenfelder's First Job. Followed Old South Penn Railroad at This Point

Why the Barber-Greene



"operates continuously"

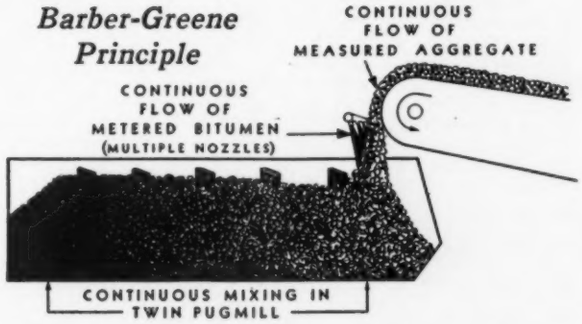
CONTINUOUS *operation* allows the B-G Mixer to handle a relatively small amount of material at any given moment. This permits a machine of comparatively small size and weight for its high daily capacity.

Continuous operation means that the aggregates and bitumen are fed into the starting end of the twin pug mill in *continuous* small streams of the correct proportions—not in batches or surges that require more power, and longer mixing.

Continuous operation means less segregation—more thorough mixing. The twin pug mill is not required to mix mass lumps of the individual materials in the limited time available.

The human element is practically eliminated. Once set, the proportions remain constant thru *continuous* volumetric measuring. The mixing time, being *continuous* remains constant, and the capacity per hour stays closer to the top limit. A *continuous* machine requires less operating skill, and the consistency of its speed greatly simplifies job co-ordination.

Barber-Greene Principle


CONTINUOUS FLOW OF MEASURED AGGREGATE
CONTINUOUS FLOW OF METERED BITUMEN (MULTIPLE NOZZLES)
CONTINUOUS MIXING IN TWIN PUGMILL

Easily set-up and knocked down, the Mixer can be towed behind a truck.

Phone, write, or wire Barber-Greene Company, Aurora, Illinois.

39-23

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Standardized Belt Conveyors
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Permanent CONVEYORS
and other standardized unit parts
SNOW LOADERS for high speed removal
MIXERS for Bituminous or Stabilized Mixing . . . Central or Travel Plant
Leveling-Tamping FINISHERS
LOADERS for lowest cost loading
Vertical Boom DITCHERS
Low Cost-High Quality Road Construction

EQUIPMENT LIST

4 Power shovels, 1 to 2 yd.; 3 Power cranes, ¾ to 1 yd.; 3 Tractors and scrapers, 30 yd.; 6 Tractors and scrapers, 12 yd.; 7 Tractors and bulldozers; 1 Tractor and pusher, large; 9 Rollers, 10-ton; 1 Rooter, 3 ft.; 2 Motor graders, 12 ft.; 1 Pull grader, 12 ft.; 15 Trucks, 10 wheel dual drive, end dump; 4 Trucks, 10 yd., end dump; 7 Trucks, 5-ton, end dump; 3 Trucks, 4-ton, end dump; 2 Trucks, pickup; 8 Truck-mounted transit mixers, 2 yd.; 1 Paver, 27E; 1 Batch plant, 3 bin complete; 1 Cement bin, 200 bbl.; 7 Compressors; 6 Wagon drills; 4 Pumps, 300 to 500 gpm.; 5 Light plants, 1500 kw.; 6 Concrete vibrators.

• •

Contract No. 7

Guthrie-Marsch-Peterson Digging 97-ft. Mt. Joy Cut. Third Deepest on Turnpike.

EQUIPMENT LIST

4 Power shovels, 2-2½ yd., 1-⅜ yd.; 1 Power crane, 2 yd.; 4 Tractors and scrapers, 12 yd.; 2 Tractors and scrapers, 15 yd.; 2 Tractors and rooters, 3 ft.; 8 Wagons, truck type, 15 yd., bottom dump; 11 Trucks, 12 yd., end dump; 2 Trucks, pickup; 5 Tractors and bulldozers; 1 Motor grader, 12 ft.; 1 Pull grader, 12 ft.; 4 Rollers, 10-ton; 1 Paver, 27E; 4 Compressors, 100 cu. ft.; 4 Wagon drills, 6 and 10 cu. ft.; 6 Jack drills; 3 Air tampers; 3 Concrete buckets; 4 Light plants, 2 1500 kw., 2 5000 kw.; 17 Floodlights, 1500 w.; 2 Electric welders, 400 amp.

• •

Contract No. 8

Nello L. Teer's First Section. Cuts Through Unsettled Country Between Ray's Hill and Sideling Hill Tunnel.

EQUIPMENT LIST

5 Tractors and scrapers, 12 yd.; 4 Tractors and bulldozers; 2 Tractors, crawler, large; 2 Rollers, 10 ton; 6 Wagons, truck-type, 6 yd., bottom dump; 1 Power shovel, 1½ yd.; 1 Motor grader, 12 ft.; 1 Pull grader, 12 ft.; 1 Rooter, heavy duty; 1 Compressor, 315 cu. ft.; 1 Wagon drill; 2 Jackhammers; 1 Welder, elec.; 1 Truck, pickup.

Contract No. 9

Empire Construction Co. Hits Hard Rock, Requiring Blasting and Shovels, Near West End of Contract.

EQUIPMENT LIST

4 Power shovels, 1½ to 2½ yd.; 6 Wagons, crawler, 14 yd., end dump; 6 Wagons, crawler, 11 yd., end dump; 11 Tractors, crawler, large; 3 Scrapers, 12 yd.; 1 Tractor and side push dozer; 2 Tractors and bulldozers; 1 Motor grader, 12 ft.; 2 Pavers, 27E; 6 Wagon drills; 5 Compressors, 115 to 315 cu. ft.; 2 Vibrators, concrete.

• •

Contract No. 10

County Construction Co. Gouges Out One of Few Cuts Atop Allegheny Plateau.

EQUIPMENT LIST

4 Power shovels, 1½ to 2 yd.; 1 Power crane, 2 yd.; 1 Steam crane; 2 Pavers, 27E; 7 Tractors and scrapers, 12 yd.; 1 Scraper, 12 yd.; 7 Tractors and bulldozers; 6 Motor graders, 12 ft.; 8 Rollers, 10-ton; 7 Compressors; 1 Wagon drill; 10 Trucks, 5-ton, end dump; 2 Trucks, 3-ton, end dump; 1 Truck, pickup; 2 Pumps, 200 gpm.; 3 Concrete vibrators; 1 Concrete bucket, 9 ft.; 7 Truck mounted transit mixers.

• •

Contract No. 11

McCrady Construction Co. Employs a Self-Powered Scraper in Tandem With Another Make at Western End of Turnpike.

Facts that MUST be faced!

. . . IF YOU WANT LOWEST COST PER YEAR IN PAVEMENT SERVICE

Has lowest maintenance and longest life

•

A modern, even, travel-surface for traffic

•

High salvage after unusually long service

•

Withstands both weather and traffic damage

•

Pre-manufactured surface; easily inspected

•

The hardest, densest and toughest material

•

Arrests deterioration of base courses

•

Easily repaired with simple hand tools

•

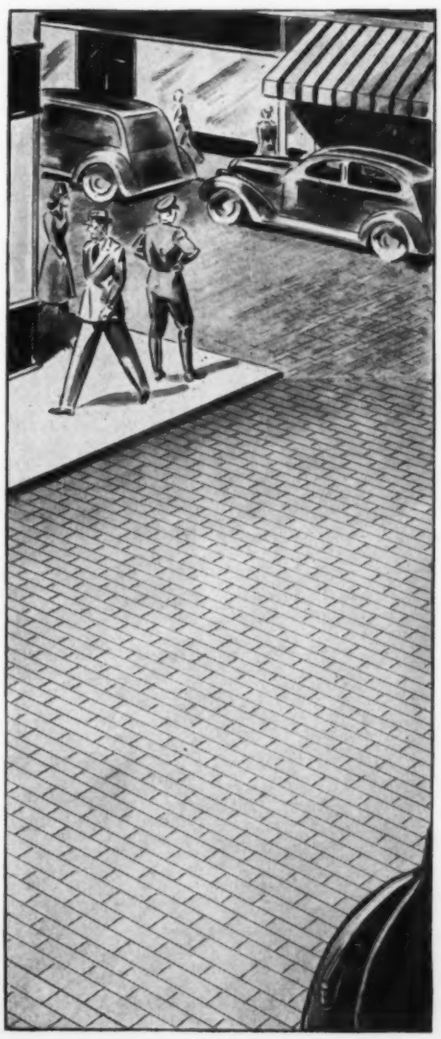
Amply visible; no glare by day or night

•

Permits Built-in markers for traffic lanes

•

Has the only factory-built safety surface



Whether you are paving a trunk-line highway or an obscure residential street, it is true economy to use brick.

It is much more resistant to weather damage to which all pavements are necessarily exposed. Brick is *too* tough, *too* indestructible to be destroyed by weather and traffic combined!

The greater your mileage of brick, the less interruption to traffic. And less pressure for repairs and reconstruction costs.

Brick has been made and used for more than 50 centuries. Yet in only the last decade many improvements have been made in its manufacture. And in the technique of using brick in pavements, more progress has been made than in all the years before!

You can build your community a brick pavement today that will far exceed even the unmatched performance of brick pavements of the past.

For further information, write to National Paving Brick Manufacturers Association, National Press Building, Washington, D. C.

BRICK

RESISTS DAMAGE FROM SALT AND CHEMICALS USED IN SNOW AND ICE REMOVAL

EQUIPMENT LIST

4 Power shovels, ¾ to 2 yd.; 2 Truck cranes, ⅜ yd.; 2 Power cranes, 10 bbl. and ¾ yd.; 6 Trucks, 3½ yd., end dump; 4 Trucks, 8 yd., end dump; 3 Trucks, service; 6 Tractors and scrapers, 12 yd.; 5 Tractors and bulldozers; 1 Rooter; 2 Motor graders, 12 ft. and 8 ft.; 5 Compressors, 110 and 220 cu. ft.; 5 Jackhammers and busters; 3 Wagon drills; 6 Rollers, 10-ton; 1 Paver, 27E; 7 Pumps, centrifugal, force, and sump; 1 Ditching machine; 6 Concrete vibrators; 1 Light plant, portable.

• •

Contract No. 12

Arundel Corporation Reopening Approach Cut to West Portal Sideling Hill Tunnel.

EQUIPMENT LIST

2 Power shovels, 100 hp. elec. motors; 2 Power shovels, ¾ and 2 yd.; 1 Truck crane, ⅝ yd.; 2 Trucks, 5-ton, flat bed; 5 Trucks, 15-ton, end dump; 1 Truck, 10-ton, end dump; 2 Trucks, pickup; 1 Truck, 5-ton, stake body; 2 Wagons, truck type, 8 yd., bottom dump; 4 Trucks, 5-ton, drill carriage; 4 Tractors and crawler wagons, 14 yd.; 1 Tractor, 35 hp.; 1 Tractor, 20 hp.; 6 Compressors, stationary, 1302 cu. ft., 20 hp. electric motor driven; 5 Compressors, 315 cu. ft.; 18 Pneumatic drifter drills; 7 Jackhammers; 2 Pneumatic tampers; 4 Wagon drills; 2 Welders, elec., 300 amp.; 3 Rollers, 10-ton; 3 Tractors and bulldozers; 2 Drill sharpeners; 5 Light plants, 800 to 1500 watt; 1 Mixer, 14S; 1 Grout machine; 4 Pumps, centrifugal, 2 to 3 in.; 8 Pumps, air sump; 1 Table saw; 1 Band saw; 1 Bolt threading machine; 2 Blowers, 10 ft.; 4 Blowers.

• •

Contract No. 13

Hunkin-Conkey Construction Co. Has Completed Widening of Old Laurel Hill Tunnel, West End.

EQUIPMENT LIST

2 Power shovels, 1½ and 2 yd.; 2 Electric shovels, 75 and 78 hp.; 1 Power drag line, 2 yd.; 2 Diesel locomotives, 16-ton and 8-ton; 24 Muck cars, large; 2 Powder cars; 2 Flat cars; 2 Drills, truck mounted; 11 Jackhammers; 2 Pavement breakers; 3 Air Compressors; 4 Compressors, stationary, 100, 125 and 150 hp. elec. motors; 2 Grinders, electric and drill bit with extra motors and wheels; 5 Tractors and bulldozers; 2 Tractors and scrapers, 12 yd.; 3 Electric welders; 2 Motor-generator sets; 3 Electric saws; 2 Drill sharpening presses; 3 Rollers, 10-ton; 1 Motor grader, 12 ft.; 2 Mixers, 13S; 5 Pumps, centrifugal, sump and force, 3 and 4 in.; 1 Wagon drill; 1 Truck, service; 1 Lathe, 16 in.; 3 Acetylene welding sets; 1 Conveyor, bucket; 1 Gunite machine; 1 Rivet hammer; 1,000 ft. Park cable; 1 Exhauster, planovane; 4 Transformers, 25,000 v.; 1 Circuit breaker, oil; 1 Line starter induction motor, 30 hp.; 1 Light plant, portable; 2 Cars, service.

• •

Contract No. 14

Connell and Laub Construction Co. Has Finished Erection of This Single Span Plate Girder Which Carries Pennsylvania 31

EQUIPMENT LIST

Same as No. 4.

• •

Contract No. 15

L. M. Hutchison Co. Uses Shovels and Trucks, as Well as Tractors and Scrapers on This Second Contract.

EQUIPMENT LIST

5 Power shovels, ⅜ to 2 yd.; 15 Trucks, 2 yd., end dump; 3 Trucks, 12 yd., end dump; 2 Motor graders, 12 ft.; 6 Tractors and scrapers, 12 yd.; 3 Compressors, 215 and 315 cu. ft.; 4 Rollers, 10-ton; 1 Mixer, 13S; 2 Pavers, 27E; 1 Tractor and bulldozer; 2 Pumps, centrifugal, 4 in.; 4 Concrete vibrators.

• •

Contract No. 16

Frank Mashuda Finds Crawler Wagons Particularly Advantageous in Rough, Rocky Work.

new 604

A NEW SHOVEL BY KOEHRING . . . new design, modern construction with many features for lower operating and maintenance costs . . . increased yardage . . . more operating ease. Enclosed gears running in oil, anti-friction bearings, forced-feed lubrication, welded construction, less weight, greater strength, high speed are a few of the important reasons why the new Koehring 604 is a profitable investment. A new catalog, giving complete description of this new Koehring Shovel, illustrates the outstanding progress made in shovel design. Write for it today.

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HEAVY-DUTY CONSTRUCTION EQUIPMENT

EQUIPMENT LIST

4 Power shovels, ⅜ to 2¼ yd.; 1 Steam crane; 1 Power crane, ¾ yd.; 9 Trucks, 7 yd., end dump; 1 Truck, grease; 2 Trucks, gas tank; 2 Trucks, pickup; 3 Crawler wagons, 16 yd.; 5 Tractors and bulldozers; 5 Tractors and scrapers, 12 yd.; 3 Tractors and sidepush dozers; 1 Tractor, pusher; 1 Rooter, 3 ft.; 3 Motor graders, 11 and 12 ft.; 6 Rollers, 10-ton; 5 Compressors, 110 and 310 cu. ft.; 2 Wagon drills; 1 Pump, centrifugal, 6 in.; 1 Welder, elec.; 2 Light plants, 1500 kw.; 3 Light plants, small.

• •

Contract No. 17

Guthrie-Marsch-Peterson Clears Away Debris at New West Portal of Allegheny Tunnel.

EQUIPMENT LIST

6 Power shovels and cranes, elec., 1 to 2½ yd.; 4 Locomotives, battery, 10-ton; 3 Trucks, ¾-ton, service; 2 Trucks, 1½-ton, end dump; 1 Truck, 3-ton, end dump; 2 Trucks, 5 yd., end dump; 6 Tractors, crawler, large; 12 Wagons, crawler, 13 yd.; 2 Tractors and bulldozers; 3 Wagons, trail, 13 yd.; 2 Muckers, 1½ yd.; 1 Mixer, 14S; 3 Compressors, 110 to 315 cu. ft.; 4 Compressors, stationary, 1,000 cu. ft.; 2 Fans, elec., 26 in., 100 hp.; 1 Pile hammer, steam; 2 Motor-generator sets, 20 kw.; 1 Well-drill, 1,000 ft.; 3 Rollers, 10 ton; 26 Industrial cars, 6 yd.; 1 Motor grader, 12 ft.; 2 Wagon drills; 2 Pumps, elec., 110 gpm.; 1 Welder, elec., 220-440 v.

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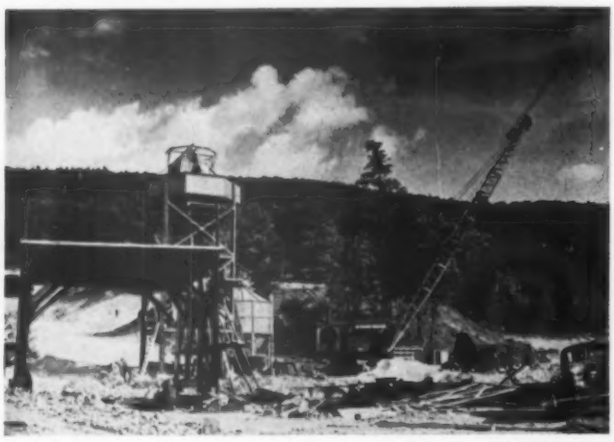
Contract No. 18



Bates and Rogers Set Up Batching Plant in Narrow Valley Between Their Blue and Kittatinny Mountains Tunnel Jobs. Jumbo in Foreground Now Serving Purpose in East End of Kittatinny Tunnel.

EQUIPMENT LIST

2 Locomotives, battery, 10 ton; 2 Locomotives, diesel, 10 ton; 2 Locomotives, diesel, 16 ton; 1 Motor-generator set, 20 kw.; 1 Power shovel, elec., 1¼ yd.; 16 Industrial dump cars, 5 yd.; 7 Industrial dump cars, 4 yd.; 11 Car trucks; 3 Compressors, twin stationary, 90E.H.; 3 Air receivers, 10 in. intake; 2 Mixers, 28S and 14S; 2 Induction motors; 9 Pneumatic drifters, wet; 6 Jackhammers; 6 Spaders and scoops; 2 Tractors, crawler, large; 1 Threading machine; 5 Transformer, elec.; 1 Tractor crane; 2 Motor pumps; 2 Pumps, centrif., 4 in.; 3 Pumps, duplex; 1 Pump, ¼ valve; 1 Grout machine, 2 valve; 1 Drill sharpener, complete; 3 Saw rigs, variable sizes; 1 Concrete breaker; 1 Clam shell bucket; 1 Dragline bucket, 1½ cu. yd.; 1 Dump bucket, bottom; 2 Blowers, motor, 12,000 cfm.; 1 Blower; 1 Bucket loader; 2 Drills, elec.; 1 Drill press, hand; 3 Derricks, small, fixed boom; 1 Motor grader, 12 ft.; 1 Furnace; 1 Turbine generator; 2 Floor hoppers; 3 Jacks, track; 1 Jack, high lift, 25 ton; 2 Jacks, ratchet, 25 ton; 1 Chain hoist, 3 ton; 4 Light plants, portable; 4 Lightning arrestors; 4 Circuit breakers, 250 v.; 2 Trucks, service; 1 Crab, hand; 1 Stack and die set, complete; 1 Scales wheelbarrow; 2 Fuel tanks; 1 Vibrator, concrete; 1 Gas torch set; 7 Wheelbarrows; 1 Welder, elec.; Miscellaneous small tools.

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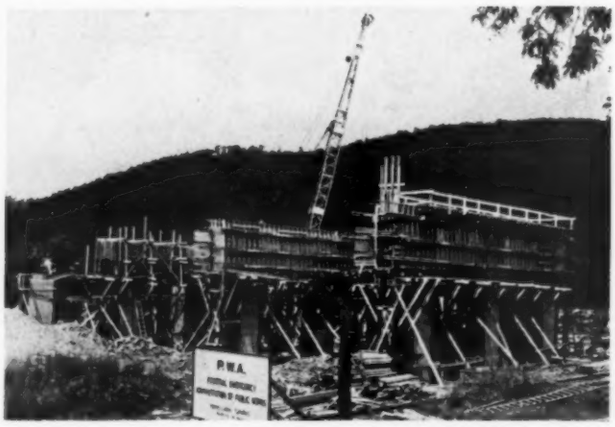
Contract No. 20



York Engineering Co. Erecting Concrete Bents for Juniata River Viaduct. Twenty-five Ton Revolving Crane in Background Operates on Wide Track.

EQUIPMENT LIST

1 Power shovel, 1¼ yd.; 1 Revolving crane, 25 ton; 1 Locomotive crane, 60 ton; 1 Hoist and engine; 1 Compressor; 2 Pumps, centrif., 2 and 3 in.; 1 Pump, diaph., 4 in.; 7 Vibrators, concrete; 1 Welder, elec.; 2 Trucks, service.

• •

Contract No. 21

York Engineering Co. Preparing Holes for Next Shot.

EQUIPMENT LIST

4 Power shovels, 1¼ and 2¼ cu. yd.; 1 Power crane, 1 yd.; 2 Wagons, crawler, 16 yd., side or end dump; 3 Trucks, 12 yd., and dump; 6 Trucks, 3 ton, end dump; 1 Truck, pickup; 4 Transit mixers, truck mounted; 3 Tractors and scrapers, 12 yd.; 4 Tractors and bulldozers; 1 Tractor, crawler, large; 1 Rooter; 4 Rollers, 10 ton; 2 Motorgraders, 12 ft.; 1 Pull grader, 12 ft.; 3 Air Compressors, 210 cu. ft.; 4 Wagon drills; 2 Jackhammers; 4 Light plants.

Contract No. 23

Ferguson and Edmondson Co. Providing Approach Fill to New Stanton Viaduct.

EQUIPMENT LIST

3 Power shovels, ¾ to 1½ yd.; 1 Power crane, 25 ton; 4 Buckets, clamshell; 5 Buckets, concrete; 1 Pile driver, No. 2, 40 hp. boiler; 2 Mixers, 27S; 2 Tractors and bulldozers; 1 Compressor, 210 cu. ft.; 7 Jackhammers; 3 Tampers, pneumatic; 3 Saw tables; 2 Rollers, 10 ton; 1 Scraper, 12 yd.; 1 Truck, winch; 1 Welder, elec.; 7 Pumps, centrif., to 4 in.; 1 Bandsaw, portable; 3 Vibrators, concrete; Trucks, end dump.

• •

Contract No. 24

Mason and Hanger Co., Which 50 Years Ago Worked on the Old South Penn Railroad, Now Excavating Approach to Ray's Hill Tunnel for the Turnpike.

EQUIPMENT LIST

2 Power shovels, elec., 1 and 1½ yd.; 1 Power crane, 1½ yd.; 1 Truck crane, ½ yd.; 6 Hauling units, 2 way drive, 6 yd., end dump; 12 Drifter drills; 1 Compressor, stationary, 1,100 cu. ft.; 2 Compressors, stationary, 1,200 cu. ft.; 1 Pneu. drill sharpener; 1 Furnace; 2 Tractors and bulldozers; 2 Ventilating fans, 12,000 cu. ft.; 3 Mixers, 27s, 2 fixed, 1 portable; 1 Concrte pumping unit, complete; 1 Cement gun; 1 Aggregate bin, 250 ton; 5 Locomotives, battery, 6 ton. More equipment coming in.

• •

Contract No. 25

B. Perini and Sons Widen Old Approach Cut at East Tuscarora Tunnel Portal. Note Displacement of Old Stone Lining After 50 Years.

EQUIPMENT LIST

5 Power shovels, 1 to 2 yd.; 1 Power crane, 1 yd.; 8 Trucks, 3 ton, end dump; 2 Trucks, 1½ ton, end dump; 4 Trucks, 10 ton, end dump; 4 Trucks, service; 1 Auto, service; 1 Motor grader, 10 ft.; 4 Tractors and bulldozers; 2 Rollers, 10 ton; 5 Compressors, 105 and 315 cu. ft.; 2 Compressors, 2,000 cu. ft.; 4 Wagon drills; 10 Jackhammers; 2 Pneumatic tampers; 1 Paver, 27E; 1 Mixer, 13S; 2 Aggregate bins, 200 ton; 2 Pumps, centrif., 3 in.; 2 Welders, elec., 300 amp.; 4 Blowers; 2 Light plants, 5 kw.; 2 Trucks, hoist and winch, special drive, 13 ton; 1 Truck, hoist and winch, special drive, 4 ton; 1 Truck, 3 ton; 2 Trucks, pickup; 1 Compressor, 215 cu. ft.; 1 Jackhammer; 1 Tractor, crawler.

• •

Contract No. 26

Guthrie-Marsch-Peterson Removes Coal Below Turnpike Grade.

EQUIPMENT LIST

3 Power shovels, 1 to 2½ yd.; 2 Power cranes, 1½ yd.; 4 Power draglines, ½ and 1¾ yd.; 8 Wagons, crawler, 10 yd.; 10 Wagons, truck type, 15 yd., bottom dump; 2 Trucks, 12 yd., end dump; 3 Trucks, 1½ ton, service; 2 Elevating graders, 48 in.; 4 Tractors and scrapers, 12 yd.; 2 Tractors and scrapers, 15 yd.; 4 Tractors and bulldozers; 2 Rooters, 3 ft.; 1 Motor grader, 12 ft.; 4 Rollers, 10 ton; 1 Compressor, 315 cu. ft.; 2 Pneumatic tampers; 6 Pumps, centrif., 4 and 6 in.; 2 Pavers, 27E; 4 Vibrators, concrete; 2 Grinders, concrete.

• •

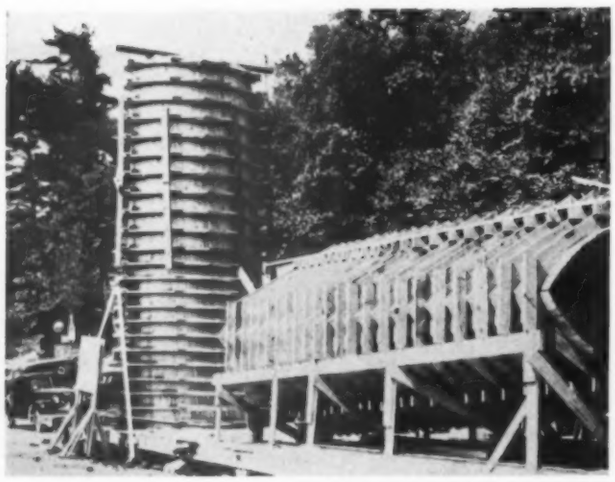
Contract No. 27

N. R. Corbisello Building Clear Creek Bridge Just West of Deepest Cut on Turnpike. Clearing Channel.

EQUIPMENT LIST

3 Power shovels, 1½ and 1¾ cu. yd.; 1 Power crane, ⅝ yd.; 4 Rollers, 10 tons; 4 Tractors and bulldozers; 1 Motor grader, 12 ft.; 3 Tractors and scrapers, 24 yd.; 3 Wagons, truck type, 16 yd., bottom dump; 2 Tractor trucks, 9 yd., end dump; 12 Trucks, 5 yd., end dump; 3 Compressors, 210 to 320 cu. ft.; 5 Wagon drills; 1 Paver, 27E; 1 Mixer, 14S; 5 Pumps, centrif. and diaph.; 5 Vibrators, concrete; 6 Light plants.

Contract No. 28



M. Bennett and Sons Prepare Forms for Dunning Creek Viaduct Piers.

EQUIPMENT LIST

5 Power shovels, ¾ to 2 yd.; 2 Power cranes, 1½ yd.; 1 Tractor and scraper, 8 yd.; 2 Tractors and bulldozers; 30 Trucks, 5 ton, end dump; 3 Rollers, 10 ton; 1 Roller, 5 ton; 1 Paver, 27E; 1 Mixer, 14S; 2 Buckets, concrete; 1 Pump, centrif., 4 in.; 3 Pumps, diaph.; 1 Pump, force, 2 in.; 1 Compressor; 1 Wagon drill; 1 Light plant; 1 Sawrig, combination.

• •

Contract No. 29

C. J. Langenfelder and Son Use 30-Yd. Scrapers on Their Second Contract. Rock Mixed With Clay Requires Pusher for Loading.

EQUIPMENT LIST

4 Power shovels, 1 to 2 yd.; 3 Power cranes, ¾ and 1 yd.; 7 Trucks, 5 ton, end dump; 3 Trucks, 4 ton, end dump; 2 Trucks, pickup; 15 Trucks, 10 wheel dual drive, end dump; 4 Trucks, 10 yd., end dump; 3 Tractors and scrapers, 30 yd.; 6 Tractors and scrapers, 12 yd.; 8 Tractors and bulldozers; 1 Rooter, 3 ft.; 9 Rollers, 10 ton; 2 Motor graders, 12 ft.; 1 Pull grader, 12 ft.; 8 Transit mixers, truck mounted, 2 yd.; 1 Paver, 27E; 1 Batch plant, complete, 3 bin; 1 Cement bin, 200 bbl.; 7 Compressors, 3/5 and 105; 6 Wagon drills; 4 Pumps, centrif., 300 and 500 gpm.; 5 Light plants, 1500 kw.; 6 Vibrators, concrete.

• •

Contract No. 32

Ferguson and Edmondson Use New Type Power Unit and Scraper Shaly Going.

EQUIPMENT LIST

5 Power shovels, ¾ to 2 yd.; 1 Power backhoe, ⅜ yd.; 1 Power crane, ¾ yd; 4 Tractors and scrapers, 12 yd.; 1 Tractor, pusher, large; 2 Tractors and bulldozers; 1 Tractor, crawler, large; 5 Scrapers, 8 yd.; 8 Wagons, truck type, 10 yd., bottom dump; 4 Wagons, truck type, 15 yd., bottom dump; 5 Trucks, 5 yd., end dump; 2 Compressors, 160 and 210 cu. ft.; 1 Wagon drill; 5 Rollers, 10 ton; 1 Mixer, 10S; 1 Paver, 27E; Miscellaneous pumps, vibrators, and small tools.

• •

Contract No. 33

Adam Eidemiller on Well Planned Centralized Work Covers One of His Culverts.

EQUIPMENT LIST

6 Power shovels, ⅜ to 1¾ yd.; 1 Power backhoe, ½ yd.; 4 Trucks, 10 yd., end dump; 2 Trucks, 8 yd., end dump; 5 Hauling units, 2-way drive, 6 yd.; 6 Trucks, 4 yd., end dump; 6 Tractors and scrapers, 14 yd.; 3 Tractors and scrapers, 12 yd.; 1 Tractor and scraper, 5 yd.; 6 Tractors and bulldozers; 2 Motor graders, 12 ft.; 8 Rollers, 10 ton; 7 Compressors, 105 to 450 cu. ft.; 4 Wagon drills; 2 Transit mixers, truck mounted, 1½ yd.; 3 Vibrators, concrete.

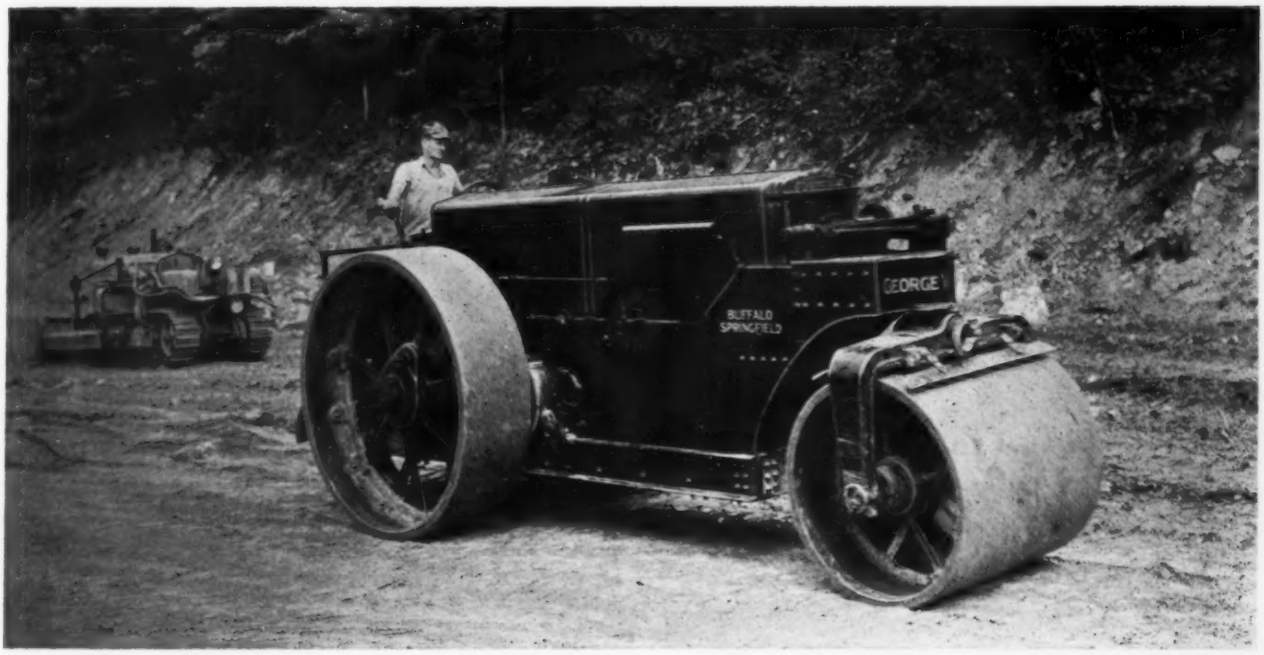
• •

Contract No. 34

George Vang, Inc., With Big Diesel Trucks, Keeps Large Shovel Reaching for the Dirt.

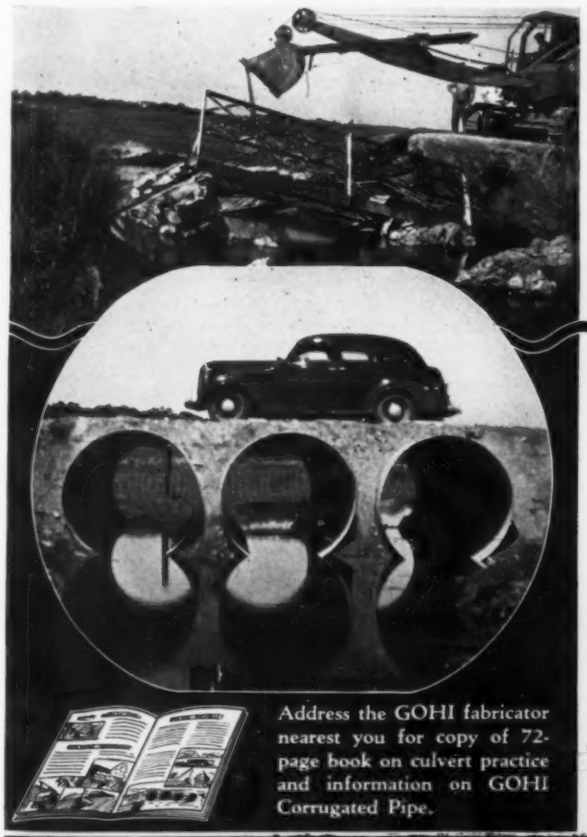
EQUIPMENT LIST

5 Power shovels, ⅜ to 2 yd.; 2 Steam shovels, 1 yd.; 2 Power cranes, 1½ yd.; 1 Power backhoe, ⅜ yd.; 1 Tractor-truck, 10 yd., end dump; 3 Trucks, 10 ton, end dump; 6 Trucks, 5 ton, end dump; 1 Truck, 1½ ton, service; 2 Transit mixers, truck mounted; 8 Tractors and scrapers, 12 yd.; 10 Tractors and scrapers, 10 yd.; 9 Tractors and bulldozers; 1 Motor grader, 12 ft.; 5 Compressors, 310 cu. ft.; 3 Rollers, 10 ton; 1 Scraper, 10 yd., on bulldozer unit; 1 Roller, steam, 12 ton; 1 Rooter; 6 Wagons, 3 yd., wooden, bottom dump; 1 Car, service.



Buffalo-Springfield rollers are figuring prominently in the compaction of the Pennsylvania Turnpike. Shown above is one of the fleet of Buffalo-Springfields owned by George Vang, Inc., at work near Somerset, Penna.

THE BUFFALO-SPRINGFIELD ROLLER COMPANY, SPRINGFIELD, OHIO



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Even the most casual observation reveals the fact that more and more large diameter GOHI Pipe is being used to replace small bridges. Lower in first cost, quickly and easily installed, long-lived, trouble-free, wear-, weather- and corrosion-resisting, GOHI Pipe is the logical modern drainage structure designed to give maximum protection to all types of roads, from the country lane to the high-speed trunk highway. Road building dollars go farther when you use GOHI Corrugated Pipe.

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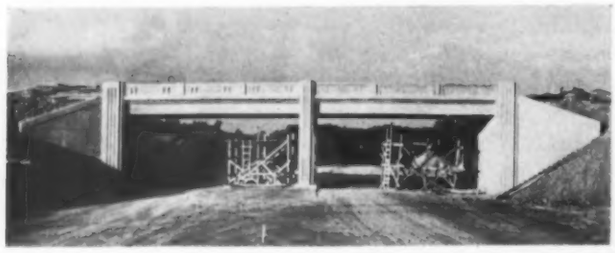
Central Culvert Co.	Ottumwa, Iowa
Capital City Culvert Co.	Madison, Wis.
Bancroft & Martin Rolling Mills Co.	S. Portland, Me.
Denver Steel & Iron Works Co.	Denver, Colo.
The Lane Pipe Corporation	Bath, N. Y.
Dixie Culvert Mfg. Co.	Little Rock, Ark.
St. Paul Corrugating Co.	St. Paul, Minn.
The Newport Culvert Co.	Newport, Ky.

GOHI CULVERT MANUFACTURERS, INC., . . . NEWPORT, KY.

Contract No. 35



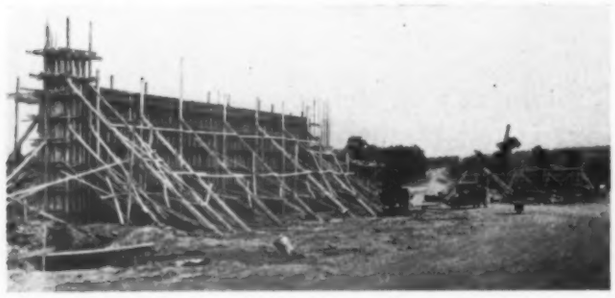
N. B. Putman Co. Finishing Grade Separation on Route of Girard's Contract. Fluting of Pier Adds Pleasing Effect.

EQUIPMENT LIST

3 Power shovels, 1 and 1½ yd.; 2 Power cranes, 1 yd.; 1 Tractor and scraper, 4½ yd.; 2 Wagons, truck type, 16 yd., bottom dump; 2 Compressors, 210 and 260 cu. ft.; 3 Rollers, 10 ton; 1 Aggregate batching plant, complete; 1 Cement bin plant, complete; 2 Tractors and bulldozers; 2 Jackhammers; 2 Pneu. tampers; 1 Tractor, crawler, large; 4 Pumps, centrif., 2 in. and 3 in.; 3 Trucks, service; 2 Pavers, 27E.

• •

Contract No. 36



H. R. Dickens Erects Forms for Plate Girder Grade Separation Carrying Heavily Traveled State Route Over the Turnpike.

EQUIPMENT LIST

1 Power shovel, 1½ yd.; 1 Power crane, 25 ton; 1 Tractor and bulldozer; 1 Compressor; 1 Pump, centrif., 2 in.; 1 Pump, diaph., 4 in.; 3 Vibrators, concrete.

• •

Contract No. 37

Dalton Bros., Inc., Use Tractors and Scrapers to Build Semi-Cloverleaf Interchange Near Fort Littleton.

EQUIPMENT LIST

4 Power shovels, ⅝ to 1½ cu. yd.; 1 Truck crane; 3 Tractors and scrapers, 14 yd.; 6 Trucks, 3 yd., end dump; 3 Trucks, 2 yd., end dump; 3 Tractors and bulldozers; 1 Motor grader, 12 ft.; 2 Compressors, 110 and 315 cu. ft.; 1 Wagon drill; 3 Rollers, 10 ton; 1 Paver, 27E; 1 Transit mixer, 1½ yd.; 3 Vibrators.

Contract No. 38

H. W. Shaull and Son Loads New Type Scrapers with Help of Pusher on Grade Approaching Blue Mountain from the East.

EQUIPMENT LIST

3 Power shovels, ⅜ to 2 yd.; 4 Wagons, truck type, 10 yd., end dump; 5 Tractors and scrapers, 14 yd.; 2 Tractors and scrapers, 10 yd.; 2 Motor graders, 12 ft.; 1 Rooter; 4 Compressors, 315 cu. ft.; 4 Light plants, 110 v.; 4 Vibrators, concrete.

• •

Contract No. 39

Walker Bros., Only Contractor Laying Paving to Date, Uses New Concrete Spreader.

EQUIPMENT LIST

2 Batching plants, complete, 105 ton; 1 Subgrader; 1 Formgrader; 1 Paver, 34E dual drum; 1 Concrete spreader; 4 Finishing machines; 1 Scratch template; 3 Motor graders, 12 ft.; 2 Rollers, 10 and 5 ton; 2 Power shovels, ¾ yd.; 2 Trucks, 5 ton, end dump; 21 Trucks, 3 ton, end dump; 2 Trucks, 1½ ton, end dump; 1 Power crane, 1½ yd.; 1 Ditching machine; 2 Compressors, 315 cu. ft.; 1 Loader, bucket; 1 Tractor and bulldozer; 1 Light plant, homemade; 6 Water tanks, truck mounted; 1 Form tamping machine; 2 Transit mixers, 1½ yd., truck mounted; 3 Pumps, centrif., 300 gpm.; 2 Pumps, diaph., 4 in.; 1 Welder, elec.; 2 Vibrators, concrete; Miles of Road forms.

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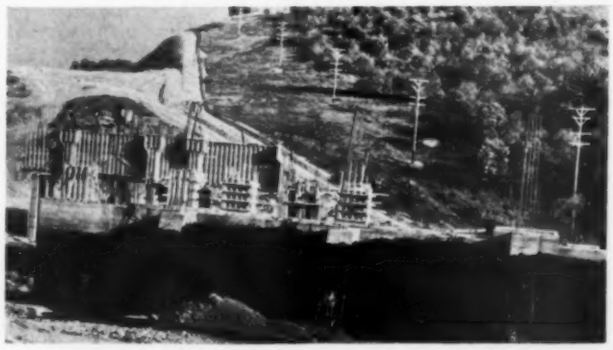
Contract No. 40



Baldwin Bros. Co. Sublet Arona Viaduct Crossing Pennsylvania Railroad at Little Sewickly Creek. West Abutment in Foreground.

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SOUTH KEARNY, N. J.

EQUIPMENT LIST

4 Power shovels, ¾ to 2 yd.; 1 Truck crane with clam, ½ yd.; 4 Tractors and scrapers, 14 yd.; 1 Power backhoe, ⅜ yd.; 3 Tractors and bulldozers; 3 Wagons, truck type, 7½ yd., bottom dump; 4 Trucks, 8 yd., end dump; 1 Motor grader, 12 ft.; 2 Pull graders, 9 ft.; 5 Rollers, 10 ton; 2 Compressors, 310 cu. ft.; 5 Wagon drills, 12 ft.; 2 Pumps, centrif., 2 in. and 3 in.; 2 Vibrators, concrete; Buying transit mix concrete as needed.

• •

Contract No. 41

Central Pennsylvania Quarry & Stripping Co. Hauls Down Steep Hillside in This Deceptive Picture. Shovel Hidden Behind Hilltop. One of Many Well Organized Outfits.

EQUIPMENT LIST

9 Power shovels, ⅜ to 2½ yd.; 6 Wagons, truck type, 10 yd., bottom dump; 17 Trucks, 10 yd., end dump; 3 Tractors and wagons, 10 yd., bottom dump; 3 Trucks, 3 ton, end dump; 3 Tractors and scrapers, 12 yd.; 9 Tractors and bulldozers; 9 Compressors, 110 to 310 cu. ft.; 10 Wagon drills; 2 Motor graders, 12 ft.; 8 Rollers, 10 ton; 2 Jackhammers; 2 Pneumatic tampers.

• •

Contract No. 42

Connell and Laub Work Borrow Pit to Provide Fill for Somerset Interchange.

EQUIPMENT LIST

Same as was used on Contract No. 4.

Contract No. 43

Herman Holmes Breaks Up Oversize Rock with Skull Cracker. Bulldozer Keeps Uniform Lift.

EQUIPMENT LIST

8 Power shovels, ¾ to 2 yd.; 2 Truck cranes, ½ yd.; 5 Power cranes, ¾ to 1½ yd.; 4 Wagons, trail type, 7 cu. yd., bottom dump; 5 Hauling units, 2 way drive, 5½ yd., end dump; 6 Hauling units, 2 way drive, 5 yd., end dump; 3 Trucks, 2 ton, end dump; 1 Truck, 2½ ton, end dump; 2 Trucks, ½ ton, pickup; 11 Rollers, 10 ton; 4 Rollers, 12 ton; 19 Tractors, 50 to 80 hp.; 8 Tractors and bulldozers; 15 Scrapers, 12 yd.; 3 Rooters; 1 Pull grader, 12 ft.; 1 Motor grader, 12 ft.; 8 Compressors, 105 to 315 cu. ft.; 6 Jackhammers; 2 Rock drills; 2 Welders, elec., 12 kw.; 2 Welders, acetylene; 7 Light plants, 1,500 to 4,000 w.; 9 Vibrators, concrete; 1 Tamper, elec.; 4 Pavers, 27E; 5 Sawrigs; 8 Tarpaulins.

• •

Contract No. 44

Nello L. Teer Uses Special Drive Trucks on His Second Contract. Note Floodlights for Night Work.

EQUIPMENT LIST

4 Power shovels, ¾ to 2 yd.; 5 Tractors and scrapers, 12 yd.; 4 Tractors and bulldozers; 2 Tractors, crawler, large; 5 Rollers, 10 ton; 6 Wagons, truck type, 6 yd., bottom dump; 6 Trucks, special drive, 6 yd., end dump; 4 Trucks, 5 yd., end dump; 9 Trucks, 2 yd., end dump; 1 Motor grader, 12 ft.; 1 Pullgrader, 12 ft.; 1 Rooter, heavy duty; 6 Compressors, 315 cu. ft.; 5 Wagon drills; 6 Jackhammers; 3 Pneu. tampers; 1 Pump, centrif.; 2 Trucks, pickup; 3 Light plants, 1,500 kw.; 2 Welders, elec.; 1 Generator, master; 1 Grease gun, power.

• •

MINNESOTA ANNOUNCES PLANS FOR $6,500,000 CONSTRUCTION PROGRAM—Plans have been approved by the Minnesota State Highway Department for a construction program on state trunk highways calling for the expenditure of $6,500,000. The program includes the following: Grading, 150 miles; stabilized base, 68 miles; gravelling, 40 miles; bituminous treatment, 188 miles; roadside development, 27 miles; pavement, 14 miles; bridges and grade separation structures, 28.

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HOTEL REFORMA
THE HOTEL OF TOMORROW

The Reforma is truly the hotel of the future, providing deluxe and ultra-modern accomodations with every facility for comfort and convenience right in the midst of Mexico's glorious recreational opportunities. American and Mexican food. Low European Plan rates.

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SAVE TIME...BUCKEYE SPREADERS make jobs move fast. Materials are handled but once.

SAVE LABOR...No follow-up work is necessary.

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Profit by this 3-way saving on your next surfacing job. Get the facts on all the advantages.

WE QUOTE THE WORDS OF USERS

"Places material just where you want it".
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"You don't have to go back over your work".
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"Almost Absolute Accuracy".
—A TEXAS CONTRACTOR.

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BUILDERS OF
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HIGHWAY WIDENERS • R-B FINEGRADERS • CONVERTIBLE EXCAVATORS

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Send at once literature and data on your Surface Material Spreader.

NAME _____

ADDRESS _____ STATE _____

CITY _____

MAIL TODAY

BID THE Buckeye WAY
ask for our operation data before you bid

Contract No. 45

Holt, McConnell and Osburn Bulldozer and Scraper Unit Stops to Gas Up.

EQUIPMENT LIST

1 Power shovel, 1½ yd.; 3 Trucks, 5 ton, end dump; 1 Mixer, 21S; 1 Compressor, 110 cu. ft.; 1 Tractor and scraper, 4 yd.; 1 Pump, force, 3 in. by 4 in.; 2 Vibrators, concrete; 1 Roller, 10 ton.

• •

Contract No. 46

John H. Swanger Uses Bulldozer for Maintaining Smooth Construction Road.

EQUIPMENT LIST

13 Power shovels, ¾ to 2 yd.; 1 Power crane, ¾ yd.; 3 Trucks, 6½ yd., end dump; 6 Hauling units, 2-way drive, 6 yd.; 13 Trucks, 4 yd., end dump; 5 Trucks, 3 ton, end dump; 2 Trucks, 4 and 5 ton, end dump; 2 Trucks, 10 ton, end dump; 2 Trucks, 4 wheel drive, experimental, end dump; 3 Trucks, service; 1 Gas tank, 520 gal., truck mounted; 2 Trucks, 1½ yd., end dump; 17 Compressors, 110 to 460 cu. ft.; 2 Compressors, truck mounted; 13 Jackhammers; 2 Pneumatic pavement breakers; 14 Wagon drills; 4 Pneumatic tampers; 12 Tractors and scrapers, 12 yd.; 14 Tractors and bulldozers; 1 Tractor, crawler, large; 1 Motor grader, 12 ft.; 11 Rollers, 10 ton; 2 Rollers, pup; 1 Pump, force, 2 in. by 2 in.; 6 Pumps, centrif., 2 in. to 4 in.; 3 Sawrigs; 2 Balch bins, 105 ton; 2 Cement bins, 75 and 240 bbl.; 2 Fine graders; 2 Pavers, 27E; 2 Finishing machines; 2 Concrete spreaders; 6 Paving bridges; 1 Formgrader; 9,000 ft. Forms, 9 in.; 2 Concrete buckets, ¾ and 1 cu. yd.; 6 Transit mixers, 2½ cu. yd., truck mounted; 1 Aggregate bin, 3 compartment; 1 Pavement surfacer; 4 Light plants, 800 watt; 4 Vibrators, concrete; 2 Tractor-mounted air drills; 1 Rooter; 6 Concrete tremies.

Contract No. 47

Johnson, Drake and Piper, Inc., Finds Easy Going at Eastern Terminus of Turnpike.

EQUIPMENT LIST

4 Power shovels, 1¼ and 1½ yd.; 3 Power cranes, ¾ to 1½ yd.; 1 Power dragline, 1¾ yd.; 1 Truck crane; 1 Truck, 15 ton, end dump; 20 Trucks, 8 yd., end dump; 3 Trucks 1½ ton, end dump; 5 Trucks, pickup; 2 Trucks, 1½ ton, service; 2 Tractors and scrapers, 9 yd.; 1 Rooter; 7 Tractors and bulldozers; 2 Motor graders, 10 ft. and 12 ft.; 7 Compressors, 200 to 500 cu. ft.; 6 Wagon drills; 10 Jackhammers; 7 Rollers, 10 ton; 1 Roller, 5 ton; 1 Paver, 34 E, dual drum; 1 Subgrader; 3 Finishing machines; 1 Concrete spreader; 1 Form grader; 1 Batching plant, 3 compartment, complete; 1 Cement bin; 12 light plants, 800 to 5000 w; 6 Vibrators, concrete.

• •

Contract No. 48

L. M. Hutchison Shuts Down on His Third Contract to Go to Sunday School.

EQUIPMENT LIST

3 Power shovels, ⅜, ¾ and 2 yd.; 8 Trucks, 4 yd., end dump; 3 Trucks, 1½ ton, service; 3 Tractors and scrapers, 15 yd.; 2 Tractors and scrapers, 12 yd.; 4 Tractors and bulldozers; 4 Rollers, 10 ton; 2 Wagon Drills; 1 Rooter; 4 Pumps, large and small; 3 Vibrators, concrete; 2 Compressors, 210 cu. ft.

Impostor Defrauding Equipment Manufacturers

Manufacturers of construction equipment have for some time been exposed to the activities of one, R. S. (Bob) Montgomery, who represents himself as an employee of Morrison-Knudsen Co., Inc., Boise, Idaho. Wherever he goes, purporting to purchase equipment for this contractor, he asks to have a check cashed for amounts ranging from $15 to $150.

Manufacturers are urged to inform the police or the Morrison-Knudsen Co. of anyone who might be suspected of being this individual.

Identifying marks—small scar (½ in.—1 in.) directly under point of chin. Large scar (4 in.) behind right elbow.

Personality—Educated, braggart, quotes poetry. Uses good English, baritone voice. Claimed to be M. I. T. graduate.

ROSS BURCH BUILT SNOW PLOWS

A model for every snow removal problem—"One-way"—"V" types — Reversible and Non-Reversible — Sidewalk plows and every type of Wing attachment. For light and heavy duty trucks and tractors (wheel or crawler type).

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Saves money and material both Summer and Winter. Use for sanding icy roads and streets or for seal coating and resurfacing. Independent motor controls width and depth of spread.

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IN THE GRADE LINE . . . up to 7 cents from every dollar !

ARE YOU throwing away materials? That's what it amounts to when you have taken care of the voids and guarded against the inaccuracies that come with hand-built finegrade. That excess material is profit lost! Many states estimate that the extra material put in the slab averages 7%. 7c on every dollar—lost! Even if this average is not correct, you know by your own core tests that you are wasting materials in guarding against this thin slab.

R. B. Power Finegraders reduce this loss and bring other decided advantages that mean better finegrade, higher production and fewer costly delays.

It will pay you to find out about R. B. before you start that next contract. Ask for our new catalog.

RB POWER FINEGRADER

R. B. EQUIPMENT DIVISION
of The BUCKEYE TRACTION DITCHER COMPANY
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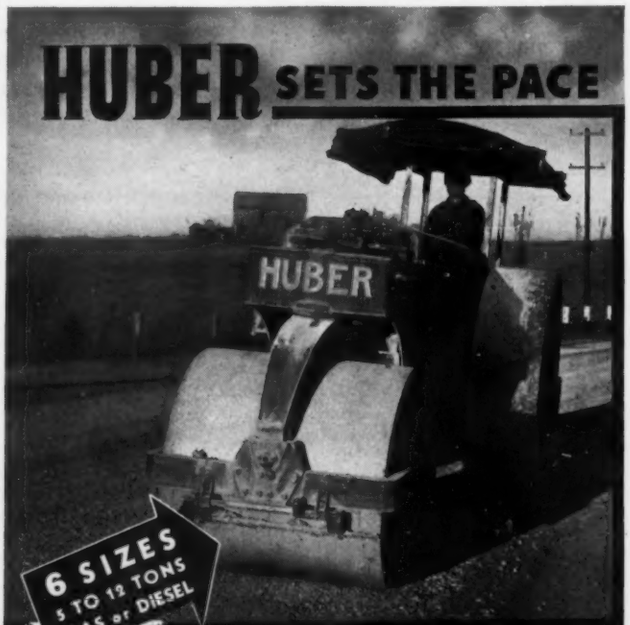
Paint Metal with
EAGLE Sublimed BLUE LEAD
STOPS RUST CHEMICALLY

COSTS LESS—PROTECTS LONGER

• Bloomfield Bridge, Pittsburgh, Pa.—protected from rust and corrosion with Eagle Sublimed Blue Lead—was repainted only once in 14 years! Yet Eagle Sublimed Blue Lead costs less per square foot of coverage than other rust-inhibitive paints. Meets Federal and A.S.T.M. specifications. Available in paste form. May also be secured from paint manufacturers by specifying Eagle Sublimed Blue Lead mixed to painting consistency.

EAGLE EP PICHER
THE EAGLE-PICHER LEAD COMPANY
CINCINNATI, OHIO

HUBER SETS THE PACE



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Buy a
HUBER
ROLLERS • GRADERS • INDUSTRIAL TRACTORS
HIGHWAY MOWERS

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ First aid dispensary, with a doctor in charge, maintained on Guthrie-

Marsch-Peterson's contract at the west portal of Allegheny tunnel on the Pennsylvania turnpike.

• •

¶ Doting, admiring uncles can easily spoil a child. Let "mom" raise her baby, I say.

¶ Grease truck used by Guthrie-Marsch-Peterson to service all equipment. Units were stopped during

operations long enough to grease up without delaying some other unit. Sometimes several stops were required to finish with one outfit.

• •

¶ We continue to feel that the No. 1 in Safety slogans is the one: *"Children* Should Be *Seen* — and Not *Hurt."*

• •

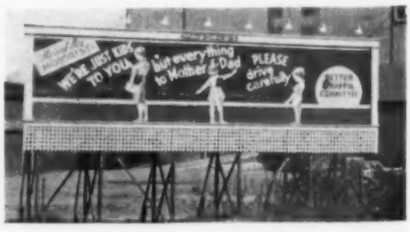
¶ Supplying fuel for the movable powered equipment on the Pennsylvania superhighway is done in vari-

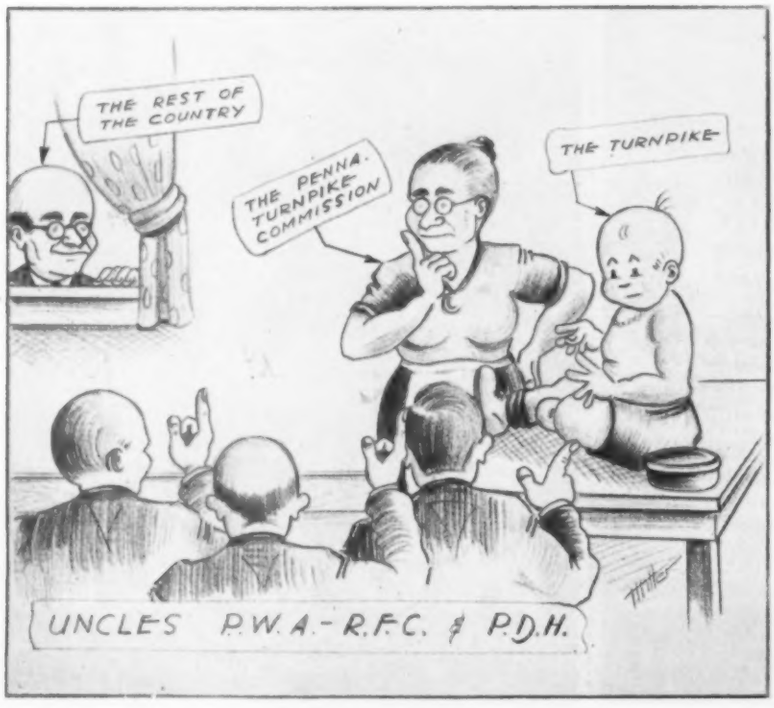
ous ways. Shown herewith are two types of tank and pump units mount-

ed by the contractors on stone boat skids. The one with the filling station type of pump is on one of Hutchison's contracts; the other is on one of Connell and Laub's jobs.

• •

¶ Pittsburgh continues the safety program of education as witnessed by the billboard shown herewith.





¶ Sunday on a part of Empire Construction Company's contract on the Pennsylvania turnpike. It's a day of

labor for mechanics and grease monkeys. Most of the other contractors were working full tilt.

• •

¶ Something new to me, and what I think is a fine idea, is the portable proportioning and mixing plant shown herewith. This self-contained

unit turns out about one-half yard of concrete per batch. It is working on the turnpike.

• •

¶ The I-beam drag shown here is used by Empire Construction Company on the turnpike for smoothing

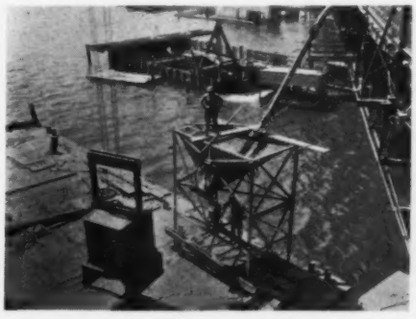
down the cut slopes. Just a huge kind of sandpaper, eh?

¶ Such a big light for such a small generator. There were about a dozen of these lights on one section of one job on the turnpike. Wood fires in

the timbered country served as night guides along one construction road between Everett and Bedford, Pa. It was Nello L. Teer's contract.

• •

¶ Pumping concrete about 800 ft. to a storage hopper with enough capacity to fill the underwater concrete depositing bucket shown on its way to



the footing of the cofferdam on Pier 7 of the Pennsylvania Avenue Bridge over the Anacostia River in Washington, D. C.

• •

¶ Those of you who were compelled to bump your way through Port Clinton, Ohio (on Ohio Route 2), will be gratified to learn that this excellent

non-skid brick highway has replaced the bumps. Shoulders were still to be maintained when this picture was taken.

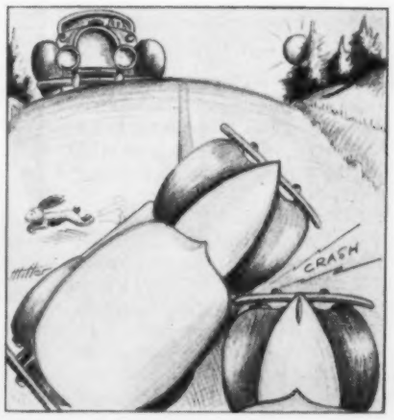
• •

¶ Brick filler excess removed by scraper made from set of plow handles. This job, in Cedar Rapids, Ia., shows removal of excess brick filler, thus restoring natural color of brick.

→

¶ The Pennsylvania Turnpike will have none of this—

¶ Nor this—



¶ Nor this—

• •

NEW EQUIPMENT AND MATERIALS

New Ford Trucks

Improvements designed for greater overall economy feature the 1940 line of Ford V-8 trucks and commercial cars. With 42 body and chassis types, six wheelbases and three V-8 engines, it is the broadest in Ford history. Hydraulic brakes are used on all units. New in the line is the 158-in. wheelbase chassis available in both conventional and cab-over-engine types. It provides an 84-in. cab-to-axle dimension on the conventional type and a 117-in. cab-to-axle dimension on the cab-over-engine type. Simplicity keynotes the new truck chassis design. Longitudinal front springs like those on Ford cab-over-engine trucks make the engine more accessible from the bottom. At the same time, accessibility of oil gage, air cleaner, spark plugs, fuel pump, carburetor and generator has been increased by lowering the sides of the hood. Still another change increases the general "under the hood" accesibility. The fan is mounted on the crankshaft in all conventional trucks making it easier to reach the distributor. A lower radiator and single fan belt contribute to ease of servicing. The new design provides for drive through the springs. This introduces chassis changes which make it much easier to service the clutch, transmission, universal joints and rear axle and facilitates the installation of special equipment. Needle-bearing universal joints are used on all trucks. Long, flexible front and rear springs with over-size pins provide exceptional cushioning for load. They also give an additional point of support for each frame side rail, which results in a decrease in frame stress due to less unsupported length. The front springs are carried on a larger, heavier front axle. A reduction in chassis weight contributes to operating economy and also leaves more of the gross vehicle weight available for payload.

New Ford V-8 Dump Truck

Hard Going 300' inside tunnel

● **Handling rock continuously . . . in close quarters 300 feet inside tunnel . . . hour after hour . . . every working day in the year, is a grueling test for any shovel.**

"Just yesterday this ⅜ cu. yd. Insley Type K loaded 152 trucks, 2¼ tons each in 7 hours," says R. W. Meisinger of Hy-Rock Products Company, Marengo, Indiana. He further adds, "In the last few months 35,000 tons of rock have been handled very satisfactorily at a surprisingly low cost."

Before you buy any shovel, get the facts about Insley. Insley Manufacturing Corporation, Indianapolis, Indiana.

Insley shovel at tunnel entrance.

INSLEY

New Heavy-Duty Cab-Over-Engine Trucks

For several years the 1½-ton cab-over-engine motor trucks of the International Harvester Co., 180 North Michigan Ave., Chicago, have been proving themselves in a variety of useful work in places where close quarters and congested traffic prevail. Now, International Harvester is entering the heavy-duty cab-over-engine field with Models D-500, DR-500, DS-500 having capacity rating of 12,300 lb. (including cab, body equipment, and pay load), and Model DR-700 having capacity rating of 18,900 lbs. (also including cab, body, equipment, and pay load). Model D-500 has a spiral bevel-gear-drive rear axle, Model DS-500 a two-speed rear axle, and Models DR-500 and DR-700 double-reduction drive rear axle. All these models are available with wheelbases of 94, 106, and 124 in. and in addition the model DR-700 may also be obtained with wheelbase of 142 in. Many important features incorporated in the design of these new cab-over-engine trucks have been time-proved in conventional International chassis. Replaceable cylinder engines, clutches, transmission, rear axles, brakes, and other units especially have stood the test of time in hard month-in and month-out service. The general chassis layouts are in many respects also similar to those of conventional chassis. The power plant

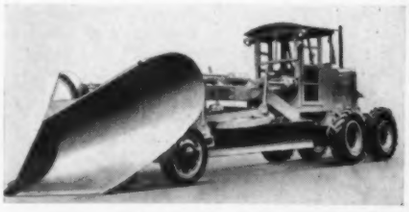
International Truck With Drop-Skirt Panel-Stake Body

of each differs mainly in that the gearshift and the brake levers arch forward over the engine placing the shift lever knob in approximately the customary location with respect to the driver's seat. The steering gear naturally is mounted ahead of the front axle. The engines of the new heavy-duty cab-over engine models are of the valve-in-head 6-cylinder type. Each engine of the D-500 model has displacement of 298 cu. in. and develops 93.7 maximum brake horsepower at 2,800 r.p.m. and maximum torque of 218 lb. ft. at 1,600 r.p.m. Bore of each D-500 engine cylinder is 3¾ in. and stroke 4½ in. As many Model D-500's will be used in highway transport service, a 361-cu. in. displacement engine is also available. This larger, more powerful engine develops a maximum of 111 h.p. at 2,700 r.p.m., and maximum torque of 269 lb. ft. at 1,500 r.p.m. The engine of the Model DR-700 has 401 cubic inches of displacement and develops a maximum brake horsepower of 114 at 2,600 r.p.m. and maximum torque of 308 lb. ft. at 800 r.p.m. For extreme conditions of highway transport or similar heavy-duty service, a 451-cu. in. diplacement engine is available. Cylinders of all models are individually replaceable. Each new cab-over-engine model is equipped with 5-speed transmission.

▼

New Heavy Duty Motor Patrol With Snow Plow

The illustration shows the Galion plow attached to a heavy duty motor patrol—the latest unit of the line of motor graders of the Galion Iron Works & Mfg. Co., Galion, O. The plow also is available for other type of Galion motor graders. The Galion plow is of all-welded construction, well braced and reinforced, and equipped with shoes to maintain road clearance of cutting edge. It can be adjusted by attachment to Scarifier control for dash operation, or can be supplied with an independent control where the grader is not equipped with scarifier or use of the latter is to be retained for fighting ice.

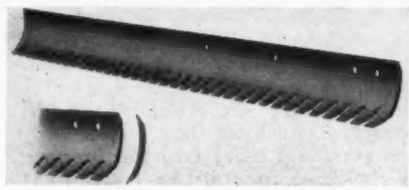


Heavy Duty Galion Grader and Snow Plow Combination

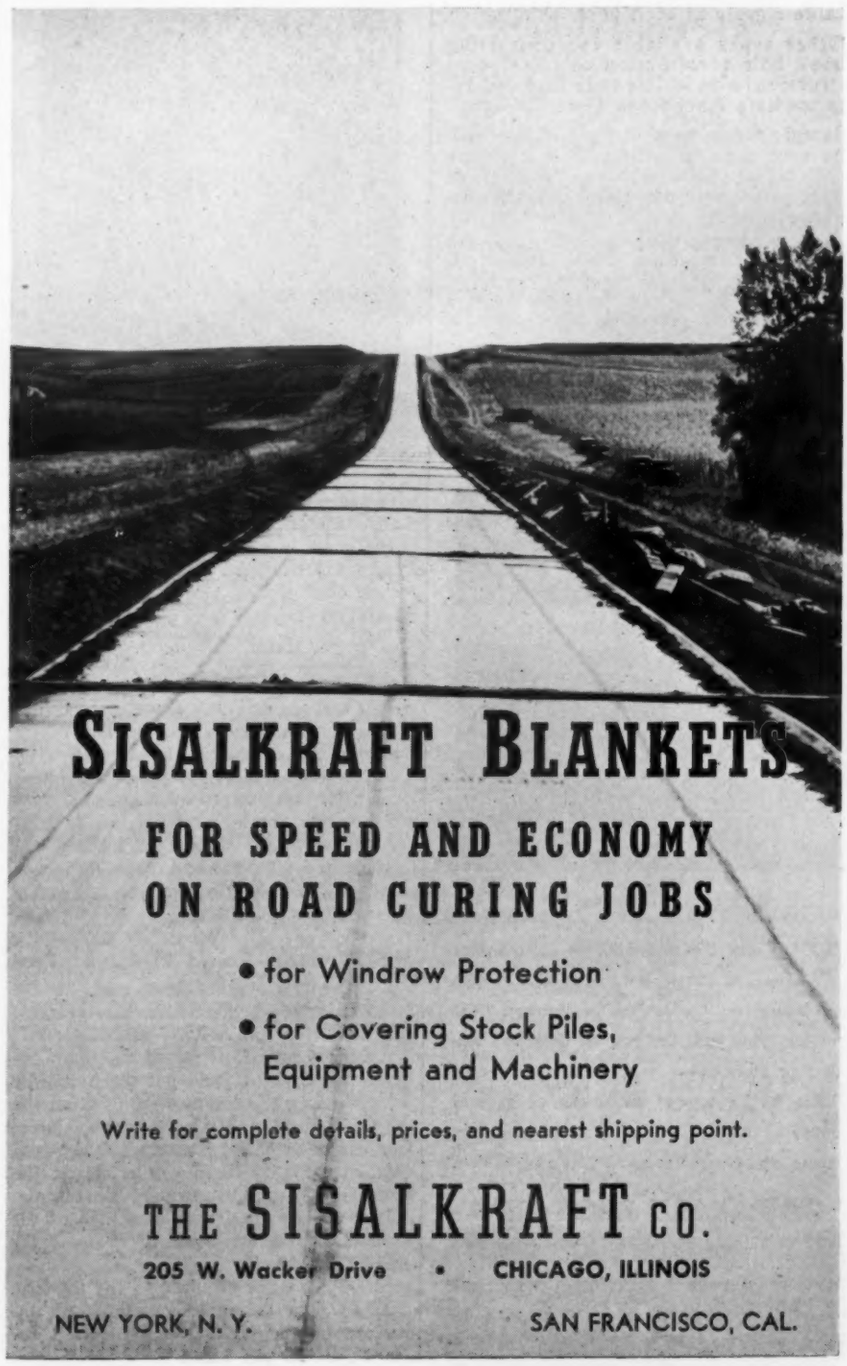
▼

New Saw-Tooth Grader Blade

A new type of blade, called the Shunk saw-tooth ice, snow, sleet and maintenance blades has been put on the market by the Shunk Manufacturing. Co., Bucyrus, O. This saw-tooth blade, on which the Shunk Manufacturing Company have patents pending, is a special grader blade, with sharpened edges, and with a series of teeth cut angling in the lower edge. The main features of the blade are the angle of the sharpened teeth which cut or score grooves parallel with the direction of travel, and the number of teeth in each blade. These blades are furnished to fit all types of graders, snow plows and maintainers, and merely replace the standard blade now on the equipment. It is claimed that usually one trip with the blade over an icy or snow packed highway or street will roughen up the roadway sufficiently to reduce the skidding hazard to a minimum, and two or more trips will loosen up the packed snow and ice so a follow-up of a regular grader or snow plow will remove the frozen material entirely. This same saw-tooth type blade also is stated to be used successfully in summer months to tear up black top, tar and macadam roads and for dirt and gravel roof maintenance for eliminating all washboard corrugation, ruts, ripples, chatter bumps, hollows and other irregularities. These saw-tooth blades are carried in stock for immediate shipment.



Shunk Saw-Tooth Blade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FOR SPEED AND ECONOMY
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Write for complete details, prices, and nearest shipping point.
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NEW YORK, N. Y.
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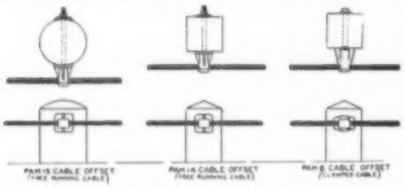
M.I.F. Cable Offsets

The Cable Offsets (patented) illustrated are preferred alternate standards in various States because of



rugged construction, attractive appearance, ease of installation and reasonable price. Two types at left for round and square posts, otherwise similar, are used with free-running cable, Compensating Spring End Anchorage construction, etc. Type at right clamps cable rigidly at each post.

Other types available for converting hook bolt construction to offset construction; also saddle type End and Intermediate Anchorage Post Offsets.

Sample recommended Cable Offset will be sent free to responsible Highway Official or Contractor on receipt of data as to post dimensions, cable rating, etc.

Other M.I.F. Specialties include: Compensating Spring Anchorages, Union Type Cable Splices, Wedge Type Cable End Sets, Offset Pipe Railings, etc.

MALLEABLE IRON FITTINGS CO.
Pole Hardware Dept.
Branford, Conn.

Dig and Haul
. . . AT LOWEST COST

Digging Boulders from River.

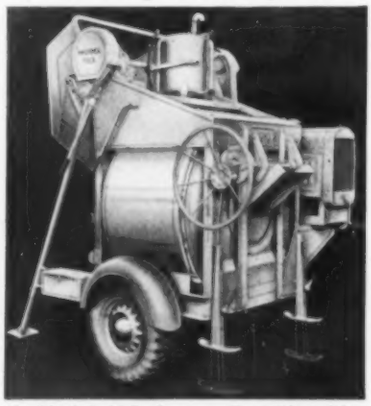
YOU can dig and haul at an average speed of 300 to 400 ft. per minute with a Sauerman Cableway or Scraper Machine. This cuts the cost of any excavating or stock-piling work where materials have to be moved distances of several hundred feet. We'll be glad to give you some cost figures or send you our catalog.

SAUERMAN BROS., INC.
488 S. Clinton St. CHICAGO

SAUERMAN
LONG RANGE MACHINES

New Concrete Mixers

An automotive type transmission is one of the many features of the 1940 speedline concrete mixers just announced by the Jaeger Machine Co., Columbus, O. It consists of machined, heat treated alloy steel gears and heavy duty ball bearings, fully enclosed from dirt or weather, and running in oil. This improved transmission is standard on all sizes from 5S up. The shaft load is divided. One set of gears drives the drum through a short chain to ball bearing drum pinion shaft and a separate set of gears provides right angle drive through a chain to the ball bearing skip hoist shaft overhead. There is no backlashing of the skip cable. In addition, semi-steel is used in all sprockets and the one-piece drum gear. The purpose of the 1940 Speedline's construction is to combine heavy duty service with the advantages of light, portable, and discharge trailer design. This construction is the same in all sizes, from 5S to 14S. Drums are equipped with machined high carbon steel tracks, and they are carried on chilled, ground-face carwheel rollers. Weight savings are effected by compact and discharge design which Jaeger originated. Pneumatic tires, Timken bearing wheels and spring shock absorbers are furnished for high speed trailing and easier maneuvering of mixers up to 14S size. Two or four-wheel mountings are interchangeable, with improved adjustable supports to take the load off tires while mixers are working. Weight of loading end is supported from the top frame by means of the two full-length supports, adjustable to various ground levels.



1940 *Model 10S Jaeger Speedline Mixer*

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New Variable Speed Hydraulic Jack

A new addition has been made to the line of Jacks of The Buda Co., Harvey, Ill. This new model is a "variable speed" hydraulic type. It is stated to be an entirely new type of jack, but the hydraulic principle is the same as that used on the complete line of Buda hydraulic jacks. One of the principal features of the "variable speed" jack is the fulcrum on the lever socket. Adjustment of the fulcrum center changes the length of stroke of the lever bar, and consequently changes the speed at which the load is raised or lowered. The power required to lift the load changes with the speed. Because of this feature of the jack, it can be used for 10, 15, or 20 ton loads.

New Pit Lift Air Jack

A jack, to be marketed as the "Alemite pit lift air jack," has been added to the line of automotive equipment of the Alemite Corp., 1828 West Diversey Ave., Chicago, Ill. For use in service stations, and fleet repair and maintenance shops, the Alemite pit lift is designed to support body and engine weight, so that lubricants can flow freely around all important chassis bearings, such as king pins, shackles, and springs when a car is being lubricated. Four models of the new device are available—all operated by compressed air. It can be used on pit, drive-on lift or free-wheel lift and has a capacity of 1½ tons. The pitlift or jack is placed under the exact point where lifting pressure may be best applied, contacting axle or chasses frame member. Air is then applied through the standard type airline chuck and the jack saddle elevated as much as 5 in. In this manner, the various lubrication points are "relaxed" and weight is removed so that lubricant can flow freely to all bearing surfaces. The pit lift raises and holds the car weight without shaking or rocking.

Alemite Pit Lift Air Jack

▼

Coating Difficult Stones with Asphalt

Road tests are being conducted by several state highway departments of a new process for assuring a permanently adhering coating of asphalt on certain dry stones and for coating any stone when wet. Four test road strips of mixes made with wet stone have been laid and four more are being arranged. Mixes of "very difficult" stone made with the new process are stated to have been tested successfully under the Goldbeck wheel. Successful test runs are stated also to have been made with several crushed stones and gravels declared by the National Crushed Stone Association and the National Sand and Gravel Association to be typical of the "difficult" stones in this country. This new process, known as the Kotal process, is a development of Herbert P. Pearson. It is controlled by the Asphalt Treatment Corporation, 140 Cedar St., New York, N. Y.

New Walking Dragline

A new and modern line of walking draglines has been announced by the Marion Steam Shovel Co., Marion, O. One of the especial features of the Marion walker is that, at the initial stage of the walking step, suction on the tub or base is broken rapidly and the movement of the base is such as to raise it quickly and thus lower the resistance against movement of the material into which the tub may have sunk. This action reduces the stresses to the operating parts during the period of movement which is reflected directly in low maintenance and greater mobility. The working movement is actuated by cranks, one on each end of a large diameter shaft, which is mounted across the rotating frame and extends outward on each side. Each crank is connected to a walking "shoe" which, when the crank is rotated, makes contact with the ground to support the weight of the machine, while the dragline moves in the desired direction. This cycle is repeated, the cranks alternately raising the walking shoes, moving them forward until they make contact with the ground and then moving the machine itself. The latest and most modern designs are incorporated in this new line of Marion walking draglines. These new Marion walking draglines are available with bucket sizes from 3 to 12 cu. yds. in capacity and booms from 80 to 200 ft. in length. Power may be either electric or diesel, at the user's option.

Marion Type 7200 Walking Dragline Equipped with a 5-cu. yd. Bucket and a 100-ft. Boom, Now in Service on One of the Placer Gold Mining Operations in California

WITH THE MANUFACTURERS

Arthur C. Evans Now with Gar Wood

Jack B. Haile, Manager of the road machinery division of Gar Wood Industries, Inc., Detroit, Mich., has announced the appointment of Arthur C. (Art) Evans to the engineering staff. Mr. Evans was formerly connected with the Continental Roll and Steel Foundry Company of East Chicago, Indiana. The Continental tractor equipment division was recently acquired by Gar Wood Industries, Inc.

A. C. Evans

Tommy Tucker Now with Brooks Equipment

The Brooks Equipment & Mfg. Co., Knoxville, Tenn., has appointed R. S. (Tommy) Tucker as its general sales manager. Mr. Tucker was formerly vice president and general manager of the Good Roads Machinery Corp. The Brooks Company, manufacturers of the "Load Luggers" and rock crushers, contemplates extending its line.

Tom Dix Is Dead

Tom Dix, one of the best known and best loved men in the technical publishing industry, died Sept. 24 at his home, 236 Oxford Road, Kenilworth, Ill., after a lingering illness. He is survived by his widow, Lucie Howe Dix, and two children Lucie Baldwin Dix and John Thomas Dix, Jr. John Thomas Dix was born Jan. 24, 1889, in Philadelphia, Pa. Since 1914 he has been located in Chicago. He was Vice President of the American City Magazine Corporation and President of the Buttenheim-Dix Pulishing Co.

Denn M. Burgess Now Vice President of LeTourneau

Denn M. Burgess, General Manager of R. G. LeTourneau, Inc., Peoria, Ill., for the past year, has, in addition, been recently elevated to the position of vice president. In connection with his new duties Mr. Burgess sailed late in August for a month's survey of the export field in France and England. With the company only since 1933 he has advanced steadily from District Representative to eastern sales manger, sales manager, and last fall to general manager, when E. R. Galvin took over sales management.

D. M. Burgess

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P. C. A. Appoints Hitzelberger District Highway Manager

W. H. Hitzelberger has been appointed district highway manager for Texas for the Portland Cement Association. The appointment became effective Oct. 1. For the present, he will continue to maintain an office in the Republic Bank Building, Dallas. Mr. Hitzelberger has a wide acquaintanceship with engineers, architects, and contractors throughout the state. He has taken an active part in civic and athletic affairs in Texas and his many friends wish him well in his important new responsibilities. From 1929 to 1938, Mr. Hitzelberger was vice president and sales manager of the Reliance Clay Products Co. of Dallas and more recently operated his own company engaged in the sale of highway materials and equipment. E. N. Gustafson, formerly assistant district engineer, has been made district highway engineer, in which capacity he will assist Mr. Hitzelberger in highway promotion and engineering. C. A. Clark, district engineer for the associaiton in Texas, will continue in charge of activities other than in the hiighway field.

▼

NEW LITERATURE

Power Shovels—Catalogs dealing with its new Type 60 power shovel have been issued by The Osgood Co., Marion, O. The main catalog sets forth details of construction and design which characterize the Type 60. Other catalogs give the specifications of the 1 cu. yd. and the 1¼ cu. yd. shovels of this model.

Rock Drills—The complete line of Ingersoll-Rand rock drills and associated equipment, together with a brief and interesting history of rock drill development, are presented in a new profusely illustrated 88-page catalog just published by Ingersoll-Rand Co., 11 Broadway, New York City. Installation and shop views as well as tables of operating and physical characteristics for each class of machine are presented in the volume. Individual sections are devoted to jackhamers, paving breakers, drifters, stopehamers, wagon drills, jackbits, drill steel, sharpeners (including thread-forgers and shank and bit punches), jackmills and jackbit grinders and a variety of other equipment including calyx core drills, coroc diamond drills, submarine drills, explorer diamond drills, etc. Eight pages of engineering tables and other useful data are also included in the book.

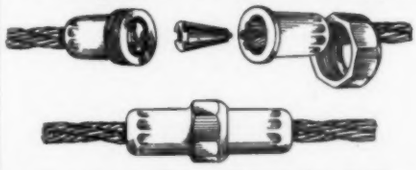
Wire Rope.—The Hazard Wire Rope Division of the American Chain and Cable Co., Inc., Wilkes-Barre, Pa., has published a new catalog on wire rope, their No. 20. It contains information of a practical and technical nature in addition to list prices and specifications of the various constructions of wire rope.

Street Signs.—The Municipal Street Sign Co., Inc., 777 Meeker Ave., Brooklyn, N. Y., has recently published a new illustrated circular describing the Type 32CY criss cross street sign and its Type 97-W and Type 97-WO wing signs.

Ice Control—"Highway Ice Control—Methods, Materials and Equipment," is the title of a new 28-page booklet issued by Solvay Sales Corporation, 40 Rector St., New York, N. Y. It gives a resumé of ice control methods now in use in various sections of the country, in addition to new facts recently developed by well-known authorities.

Armco Liner Plates for Tunnels.—An attractive folder just issued by The American Rolling Mill Co., Middletown, O., contains interesting data on Armco light-duty liner plates for small-diameter tunnels. Photographs and schematic drawings are used for illustration. Tables give approximate weights of the plates in standard gages and diameters, and other properties.

Guard Cable Splice of Approved Design



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